CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

FOR

BACHELOR OF TECHNOLOGY (B.Tech.)

(4 Year Undergraduate Degree Programme)

In

MECHANICAL ENGINEERING

(In alignment with National Education Policy, 2020)

[w. e. f. 2025-26]

FACULTY OF ENGINEERING AND TECHNOLOGY

SRM UNIVERSITY DELHI-NCR, SONEPAT

39, Rajiv Gandhi Education City, Sonepat

Haryana-131029

SRM UNIVERISTY DELHI-NCR, SONEPAT FACULTY OF ENGINEERING AND TECHNOLOGY

ENGINEERING GRADUATES EMPLOYABILITY ATTRIBUTES (EGEAs)

Sound Knowledge & Skill of Basic Science &Engineering Sciences

An Engineer should be able to apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

Problem formulation, Analysis & Solving

An Engineer should be able to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using principles of mathematics, natural sciences, and engineering sciences.

Design and Development of a Solution

An Engineer must be able to design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

Investigation

An Engineer should use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Modern Tools Usage

An Engineer should be able to create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

The Engineer and the Society

An Engineer should be able to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional Engineering practice.

Individual and Teamwork

An Engineer should be able to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Lifelong Learning

An Engineer must recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Environment and Sustainability

An Engineer must understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Professional Ethics

An Engineer should be able to apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice.

Effective Communication

An Engineer should be able to communicate effectively on complex Engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

SRM UNIVERISTY DELHI-NCR, SONEPAT

FACULTY OF ENGINEERING AND TECHNOLOGY

FACULTY OF ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES (FEPEOs)

1. Advancement to a professional position by virtue of their knowledge, skills and attitude.
2. Recognition for solving engineering problems and developing design solutions that consider safety and sustainability.
3. Work as successful professionals in diverse engineering disciplines and enterprises;
4. Increasing responsibilities of technical and managerial leadership in their work organizations;
5. Professional development through a commitment to career-long learning.

FACULTY OF ENGINEERING PROGRAM LEARNING OUTCOMES (FEPLOs)

1. An ability to identify, formulate, and solve real time engineering & socio-economic problems by applying principles of engineering, science, mathematics, humanities and social sciences
2. An ability to use the advanced skill enhancement techniques and modern engineering tools as per industry 4.0 necessary for engineering practice.
3. An ability to apply engineering design to produce solutions that meet specified needs with realistic considerations of environmental, ethical, health & safety and sustainability an ability to adapt and work with multidisciplinary teams and communicate effectively;
4. An ability to function effectively on a team whose members together provide leadership, to create a collaborative environment, to establish goals and to execute plan tasks. an understanding of professional and ethical responsibility;
5. An ability to acquire and apply new knowledge using appropriate learning strategies with inner quest to learn, unlearn and relearn.

MAPPING MATRIX OF FACULTY OF ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES (FEPEOs) AND FACULTY OF ENGINEERING PROGRAM LEARNING OUTCOMES (FEPLOs)

FACULTY OF ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES (FEPEOs)	FACULTY OF ENGINEERING PROGRAM LEARNING OUTCOMES (FEPLOs)
Advancement to a professional position by virtue of their knowledge, skills and attitude.	1. An ability to identify, formulate, and solve real time engineering and socio-economic problems by applying principles of engineering, science, mathematics, humanities and social sciences 2. An ability to use the advanced skill enhancement techniques and modern engineering tools as per industry 4.0 necessary for engineering practice.
Recognition for solving engineering problems and developing design solutions that consider safety and sustainability	2. An ability to use the advanced skill enhancement techniques and modern engineering tools as per industry 4.0 necessary for engineering practice. 3. An ability to apply engineering design to produce solutions that meet specified needs with realistic considerations of environmental, ethical, health & safety and sustainability
Work as successful professionals in diverse engineering disciplines	3. An ability to apply engineering design to produce solutions that meet specified needs with realistic considerations of environmental, ethical, health & safety and sustainability 4. an ability to adapt and work with multidisciplinary teams and communicate effectively;
Increasing responsibilities of technical and managerial leadership in their work organizations;	4. an ability to adapt and work with multidisciplinary teams and communicate effectively; 5. An ability to function effectively on a team whose members together provide leadership, to create a collaborative environment, to establish goals and to execute plan tasks. 6. an understanding of professional and ethical responsibility;
Professional development through a commitment to career-long learning.	6. an understanding of professional and ethical responsibility; 7. An ability to acquire and apply new knowledge using appropriate learning strategies with inner quest to learn, unlearn and relearn.

MAPPING MATRIX OF FACULTY OF ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES (FEPEOs) AND FACULTY OF ENGINEERING PROGRAM LEARNING OUTCOMES (FEPLOs) (TABULAR FORMAT)

Table 1

MAPPING	FEPLO01	FEPLO02	FEPLO03	FEPLO04	FEPLO05	FEPLO06	FEPLO07
FEPEO01	X	X					
FEPEO02		X	X				
FEPEO03			X	X			
FEPEO04				X	X	X	
FEPEO05						X	X

B.TECH. - MECHANICAL ENGINEERING GRADUATES EMPLOYABILITY ATTRIBUTES

The B. Tech program aims at providing a strong foundation in theoretical, practical, and design aspects of Mechanical Engineering (ME). The UG program is embraced by rigor and span to prepare a practicing engineer for a lifetime of creative work and ongoing technical learning. The curriculum covers all aspects of Mechanical Engineering under the broad categories of Design Engineering, Manufacturing Engineering, Thermal & Fluid Engineering and Mechatronics & Robotics. The syllabus comprises theory and laboratory courses. The theory course can be either a professional core (major) or a professional elective course (minor). There are various specialized identified domains in emerging areas on which minor specializations are offered by the department. Theory course with laboratory component is included, which provides a balanced mix of quality teaching of theoretical concepts and experimental verification of the learned concepts.

There are exclusive laboratory courses aimed at imparting the design knowledge of Mechanical components. The Major Project/Internship in the eighth semester and the Minor project work in the seventh semester are aimed to providing opportunities to the students, as well as guiding them to design and manufacturing using the CAD and CAE tools. Various Centre of Excellence are available for training and the design purpose of the mechanical system.

EA 1: Sound Knowledge &Skill of Domain Area: Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program

EA 2: Problem solving skills: An ability to use appropriate knowledge and skills to identify, formulate, analyse, and solve complex engineering problems in order to reach substantiated conclusions.

EA 3: Cognitive and Analytical skills: Cognitive& Analytical skills help engineering graduates interpret data, remember team goals. These skills help them recall previous information. that may relate to their organization's goals and help them make important connections between old and new information so that they can work more effectively.

EA 4: Design Thinking: An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.

EA 5: **Transferrable Skills:** Transferable skills are skills and abilities that are relevant and helpful across different areas of life: socially & professionally.

- **Interpersonal skills to work in diverse group:** An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.
- **Communication Skills:** An ability to communicate complex engineering concepts within the profession and with society at large. Such abilities include reading, writing, speaking and listening, and the ability to comprehend and write effective reports and design documentation, and to give and effectively respond to clear instructions.

- **Positive attitude and thinking:** An ability to have positive attitude and thinking in challenging situations.
- **Adaptability:** Adapts learning strategies to new conditions. Recognizes parallels, analogies or similarities of new situations to more familiar situations.
- **Learn to Learn:** Learn Unlearn Relearn: An ability to identify and to address their own educational needs in a changing world, sufficiently to maintain their competence and contribute to the advancement of knowledge.

EA6: Information technology skills: An ability to create, select, adapt, and extend appropriate techniques, resources, and modern ICT tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.

B.TECH. - MECHANICAL ENGINEERING PROGRAMME EDUCATIONAL OBJECTIVES

PEO1. To nurture strong understanding in logical, mathematical and analytical reasoning among students coupled with problem solving attitude that prepares them to productively engage in research and higher learning.

PEO2.To build strong foundation in the field of Mechanical Engineering among students to be creative and innovative.

PEO3. To prepare students capable of designing and developing real-world computing applications with high societal influence and impact.

PEO4. To provide students with academic environment that enables them to understand the significance of life-long learning in varied situations and teams in global perspective.

PEO5. To inculcate ethical practices, professionalism and environmental awareness for sustainable development among students enabling them for prospective employment in their chosen line of profession globally.

PEO6. To instil communication and management skill that generates entrepreneurship and / or leadership qualities.

B.TECH. - MECHANICAL ENGINEERING PROGRAMME LEARNING OUTCOMES

PLO1-Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and IC design and technology concepts towards modelling and prototyping Integrated systems.

PLO2-Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PLO3-Design/development of solutions: Design methodology to offer hardware solutions to public health, safety and agriculture, consumer electronics along with cultural, societal, and environmental considerations.

PLO4-Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PLO5-Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PLO6-The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PLO7-Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PLO8-Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PLO9-Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PLO10-Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehended write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PLO11-Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply the set one‘s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PLO12-Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

MAPPING MATRIX OF PROGRAM EDUCATIONAL OBJECTIVES (PEO) AND PROGRAM LEARNING OUTCOMES (PLO)

Table 2

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
PEO1	✓	✓										
PEO2			✓	✓								
PEO3					✓	✓						
PEO4							✓	✓				
PEO5									✓			
PEO6										✓	✓	✓

B.TECH. MECHANICAL ENGINEERING PROGRAMME STRUCTURE

The Mechanical Engineering curriculum is geared towards providing the student with a strong foundation in the discipline and the tools and competence to address new and challenging problems that they have not seen before. In order to earn a B. Tech. degree in Mechanical Engineering, a student should secure a minimum of 184 credits in the course of their study. The credit requirements for their program of study is comprised of the following Programme Structure:

- Basic Applied Sciences (BAS) and Engineering Science (ES):

  The purpose of Basic Applied Sciences in Engineering study is to lay a strong foundation of basic principles of various disciplines such as Mathematics, Physics and Chemistry in the mind of the learners so that they proceed to the rest of their years of study with up-to-date knowledge and training of basic engineering skills. The Engineering Sciences requirements support multiple objectives: first, the courses provide a strong foundation in the basic tools and methodologies common to all engineering disciplines; second, all students are exposed to the basics of each discipline allowing for cross-disciplinary competencies; last, there is a multi-disciplinary project component where students from different engineering disciplines come together on a design project, allowing for practice in collaborative team work.

- Professional Core Courses (PCs): The Professional core courses are aimed at providing the student with a solid foundation in their chosen field of study as per Industry 4.0 skills and knowledge.

- Practical (P):

  The labs are fully furnished and well equipped with the latest software to conduct practicals as per the requirement of the University Curriculum.

- Professional Electives (PEs) – Programme-Specific Specialization Electives:

  The Professional electives, on the other hand, provide the student with an option to gain exposure to different specializations within the discipline, or an opportunity to study one of the subfields in some depth.

- Ability Enhancement Courses (AECs)

  Students are required to achieve competency in a Modern Indian Language (MIL) along with English language with special emphasis on language and communication skills. The courses aim to enable the students to acquire and demonstrate core linguistic skills, including critical reading and academic writing skills. The focus is on imparting students with the necessary skills to articulate their arguments and present their thoughts clearly and coherently, and recognize the importance of language as a mediator of knowledge and identity.

- Skill Enhancement Courses (SECs) – Technical & Soft Skills:

  - Technical Skills: Under Technical Skills, broad categories of training is to be imparted in Engineering Graduates of various disciplines with common nomenclature. The training is categorized into three categories: Elementary, Intermediate & Advanced keeping in view the interdisciplinary approach. (One Credit each from 3rd semester to 7th semester)

- **Soft Skills:** Under Soft skills training, six soft skill courses with defined Nomenclature and course content common to all Engineering disciplines are introduced to inculcate Group Dynamics, Team work & Leadership Traits by engaging students in interactive sessions through Role Play, Group Discussions, and Improving Presentation & Communication skills of engineering graduates. (One Credit Course from 3rd Semester to 7th semester).

- Value Added Courses (VACs):

Course components related to skills, attitudes, and values are required to take appropriate actions for mitigating the effects of environmental degradation, climate change, pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, sustainable development, living health and wellness seek to promote an optimal state of physical, emotional, intellectual, social, spiritual, and environmental well-being of a person, the constitutional obligations with special emphasis on constitutional values and fundamental rights and duties

- Live Projects (LP) & Industrial Visits (IV) and Summer Internship (SI):
- Live Projects& Industrial Visits:
  - Live Projects is being introduced for all Engineering disciplines from 4th semester onwards till 7th semester to develop an ability in engineering graduates to apply skillsand knowledge attained to solve real life complex problems (One Credit each semester).
  - Apart from this, it will be mandatory to conduct at least 2 Industrial Visits each semester to provide students a proper industrial exposure.
- Summer Internship (SI):
  - Students will be monitored on periodic basis, both by the Faculty Mentor from the Industry and the FacultyIn-charge from the department. The Faculty Mentor from the Industry will submit the Mid-Term and End-Term Evaluation report. However, the faculty In-charge from the department will take periodic presentation to keep a check on the progress of Student.
  - Students are provided with the internship-related document which helps them to prepare a report. In addition to this, it provides details to students aboutinternship/project evaluation parameters.
- Multidisciplinary (Humanities and Social Sciences Courses) Courses (MDC):-

The open elective subject courses provide the student with wide latitude to pursue their interests, be it in humanities, management, arts, or their own chosen field of study in order to have a multidisciplinary approach.

PROGRAM STRUCTURE FOR BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

Table 3

Category of courses	Category	No. of Courses
Basic Applied Sciences	BAS	5
Engineering Sciences	ES	6
Professional Core Courses	PC	16
Professional Electives-Program Specific Specialization Electives	PE	11
Ability Enhancement Courses	AEC	2
Value Added Courses	VAC	4
Skill Enhancement Courses (Technical &Soft Skills)	SEC	10
Practical /Workshops	P/W	9
Live Project & Industry Visit	LP	5
Multidisciplinary (Humanities and Social Sciences Courses) Courses	MDC	3
TOTAL		71

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAMME CREDIT STRUCTURE SEMESTERWISE

Table 4

Sl. No.	Course Category	Course Code	Credits Per Semester								Total Credits	Percentage
			I	II	III	IV	V	VI	VII	VIII		
1	Basic Applied Sciences	BAS	9	9	4	-	-	-	-	-	22	12
2	Engineering Sciences	ES	8/9	8/9	-	-	-	-	-	-	17	10
3	Professional Core	PC	-	-	12	11	9	12	6	-	51	27
4	Professional Electives -Program Specific Specialized Elective Courses	PE	-	-	3	3	9	6	12	-	33	18
5	Ability Enhancement Courses	AE C	2/5	5/2	-	-	-	-	-	-	7	4
6	Skill Enhancement courses (Technical and Soft skills)	SEC	-	-	2	2	2	2	2	-	10	5
7	Value Added Courses	VAC	2	2	2	1-	-	-	-	-	6	4
8	Practical / Workshop	P/W	-	-	2	3	2	1	1	-	9	5
9	Live Project & Industrial Visit and Summer Internship	LP/SI	-	-	-	1	1	1	5	12	20	11
10	Multidisciplinary (Humanities and Social Sciences Courses) Courses	MDC	-	-	-	3	3	3	-	-	9	5
TOTAL			**22/24**	**22/24**	**25**	**24**	**26**	**25**	**26**	**12**	**184**	**100**

PROGRAM COURSE’S CREDIT STRUCTURE SEMESTER WISE

SEMESTER-I

SL. No	Code	Category	Course Name	Hours per week L	T	P	Total Hours	Credits
THEORY								
1	25AS101	(BAS)	Engineering Mathematics-I	3	1	0	4	4
OR								
1 (a)	25AS107	(BAS)	Mathematics-I (For BME students)	2	0	0	2	2
1 (b)	25AS109	(BAS)	Biology (For BME students)	1	1	0	2	2
2	25AS103/ 25AS105	(BAS)	Quantum Computation and Communication / Applied Chemistry	3	1	0	4	4
3	25EE101/ 25EC101	(ES)	Basic Electrical Engineering / Basic Electronics Engineering	3	0	0	3	3
4	25ME101	(ES)	Fundamentals of Robotics and AI	3	0	0	3	3
	OR							
	25CS101	(ES)	Fundamentals of Computer & C Programming	3	0	0	3	3
5	25HS101	(AEC)	Communicative English	2	0	0	2	2
6	25HIN101 / 25FLGR101 / 25FLFR101	(AEC)	Hindi-I/German-I/French-I	2	0	0	2	2
7	25ESEB101/ 25VAC101	(VAC)	Environmental Bioengineering / Indian Constitution and Polity	2	0	0	2	2
Total Credits (Theory)				18/16	2	0	20/18	20/18
PRACTICAL								
8	25AS153/ 25AS155	(BAS)	Quantum Physics Lab / Applied Chemistry Lab	0	0	2	2	1
9	23EE151/25EC151	(ES)	Basic Electrical Engineering Lab / Basic Electronics Engineering Lab	0	0	2	2	1
10	25ME151/25CS151	(ES)	Design thinking and Engineering practices Lab / C Programming Lab	0	0	2	2	1
11	25ME153/25HS151	(ES)/ (AEC)	Engineering Graphics & Design Lab/ Communicative English Lab	0	0	2	2	1`
Total Credits (Practical)				0	0	8	8	4
TOTAL CREDITS (THEORY + PRACTICAL)				18/16	2	8	28/26	24/22

[L= Lecture, T = Tutorials, P = Practical’s & C = Credits]

PROGRAM COURSE'S CREDIT STRUCTURE SEMESTER WISE
SEMESTER-II

SL. No	Code	Category	Course Name	Hours per week L	Hours per week T	Hours per week P	Hours per week Total Hours	Credits
THEORY								
1	25AS202	(BAS)	Engineering Mathematics-II	3	1	0	4	4
OR								
1	25AS204	(BAS)	Mathematics-II (For BME students)	3	1	0	4	4
2	25AS206/ 25AS208	(BAS)	Quantum Computation and Communication / Applied Chemistry	3	1	0	4	4
3	25EE202/ 25EC202	(ES)	Basic Electrical Engineering / Basic Electronics Engineering	3	0	0	3	3
4	25ME202	(ES)	Fundamentals of Robotics and AI*	3	0	0	3	3
	OR							
	25CS202	(ES)	Fundamentals of Computer & C Programming	3	0	0	3	3
5	25HS202	(AEC)	Communicative English	2	0	0	2	2
6	25HIN202 / 25FLGR202 / 25FLFR202	(AEC)	Hindi-I/German-I/French-I	2	0	0	2	2
7	25ESEB202/ 25VAC202	(VAC)	Environmental Bioengineering / Indian Constitution and Polity	2	0	0	2	2
Total Credits (Theory)				18/16	2	0	20/18	20/18
PRACTICAL								
8	25AS256/ 25AS258	(BAS)	Quantum Physics Lab / Applied Chemistry Lab	0	0	2	2	1
9	23EE252/25EC252	(ES)	Basic Electrical Engineering Lab / Basic Electronics Engineering Lab	0	0	2	2	1
10	25ME252/25CS252	(ES)	Design Thinking and Engineering Practices Lab* / C Programming Lab	0	0	2	2	1
11	25ME254/25HS252	(ES)/ (AEC)	Engineering Graphics & Design Lab/ Communicative English Lab	0	0	2	2	1`
Total Credits (Practical)				0	0	8	8	4
TOTAL CREDITS (THEORY + PRACTICAL)				18/16	2	8	28/26	24/22

[L= Lecture, T = Tutorials, P = Practical's & C = Credits]

*Engineering Mechanics (25CE202) and Basic Civil Engineering Lab (25CE252) will be offered to Civil Engineering students

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – III

Course Code	Course	Category	Hours Per Week				Credits
			L	T	P	Total Hours	
Theory							
23VAC301	Sports, Yoga & Fitness	VAC	1	0	2	3	2
25AS301	Engineering Mathematics-III	BAS	3	1	0	4	4
23ME301	Strength of Materials	PC	3	0	0	3	3
23ME302	Manufacturing Technology	PC	3	0	0	3	3
23ME303	Engineering Thermodynamics	PC	3	0	0	3	3
25ME304	Engineering Mechanics	PC	3	0	0	3	3
23MEXXX	Professional Elective – I	PE	3	0	0	3	3
Total			19	1	2	22	21
Practical							
23ME351	Strength of Materials Laboratory	P	0	0	2	2	1
23ME352	Manufacturing Process Laboratory	P	0	0	2	2	1
Total			0	0	4	4	2
Skill Enhancement Courses (SEC)							
24CS0201A/ 24CS0201B/ 24CS0201C/ 24CS0201D	Data Structure and Algorithms using C or C++/Industry Automation Level-I/ Digital Marketing/Fundamentals of CAD for Engineers	SEC	0	0	2	2	1
23SS351	Effective Communication Skills	SEC	0	0	2	2	1
Total			0	0	4	4	2
TOTAL (Theory + Practical + SEC)			**19**	**1**	**10**	**30**	**25**

L : Lecture T : Tutorials P: Practical	BAS : Basic Applied Sciences AEC : Ability Enhancement Course PC : Professional Core PE: Professional Elective P : Practical SEC : Skills Enhancement Course LP : Live Project

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – IV

Course Code	Course	Category	Hours Per Week				Credits
			L	T	P	Total Hours	
Theory							
23MDC401	Multidisciplinary Elective-I	MDC	3	0	0	3	3
23ME401	Fluid Mechanics	PC	3	0	0	3	3
23ME403	Design of Machine Elements	PC	4	0	0	4	4
23ME404	Computer Aided Design & Manufacturing (CAD & CAM)	PC	3	0	0	3	3
23MEXXX	Professional Elective Course – II	PE	3	0	0	3	3
25VAC201	Environmental Management & legislation	VAC	2	0	0	2	2
Total			18	0	0	18	18
Practical							
23ME451	Fluid Mechanics Laboratory	P	0	0	2	2	1
24ME452	Computer Aided Design (CAD) Lab	P	0	0	2	2	1
23ME453	Manufacturing and Assembly Drawing Lab	P	0	0	2	2	1
23LP451	Live Project-I / Internship	LP/SI	0	0	1	1	1
Total			0	0	7	7	4
Skill Enhancement Courses (SEC)							
24CS0202A/ 24CS0202B/ 24CS0202C	Introduction to SPSS Tool/Design Thinking and Augmented Virtual Reality/Programming Using Python for Engineers	SEC	0	0	2	2	1
23SS452	Teamwork & Interpersonal Skills	SEC	0	0	2	2	1
TOTAL			0	0	4	4	2
TOTAL (Theory + Practical + SEC)			**18**	**0**	**11**	**29**	**24**

L : Lecture T : Tutorials P: Practical	MDC- Multi Disciplinary Courses PC : Professional Core PE: Professional Elective P : Practical SEC : Skills Enhancement Course LP : Live Project

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – V

CourseCode	Course	Category	Hours PerWeek				Credits
			L	T	P	Total Hours	
Theory							
23MDC501	Multidisciplinary Elective-II	MDC	3	0	0	3	3
23ME501	Theory of Machines- I	PC	3	0	0	3	3
23ME502	IC Engines	PC	3	0	0	3	3
23ME503	Heat and Mass Transfer	PC	3	0	0	3	3
23MEXXX	Professional Elective Course – III	PE	3	0	0	3	3
23MEXXX	Professional Elective Course – IV	PE	3	0	0	3	3
23MEXXX	Professional Elective Course – V	PE	3	0	0	3	3
Total			21	0	0	21	21
Practical							
23ME551	Computer Aided Manufacturing (CNC) Lab	P	0	0	2	2	1
23ME552	IC Engines Lab	P	0	0	2	2	1
23LP551	Live Project-II/Internship	LP/SI	0	0	1	1	1
Total			0	0	5	5	3
Skill Enhancement Courses (SEC)							
24CS0301A/ 24CS0301B/ 24CS0301C/ 24CS0301D/ 24CS0301E	Wearable Technology/Big Data Analytics, Tools and Techniques/Machine Learning using Python/Industry Automation Level-II/RCC Structure Drawing Training	SEC	0	0	2	2	1
23SS553	Presentation Skills	SEC	0	0	2	2	1
Total			0	0	4	4	2
TOTAL (Theory + Practical + SEC)			21	0	9	30	26

L : Lecture T : Tutorials P: Practical	PC : Professional Core PE : Professional Electives MDC- Multi Disciplinary Courses

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – VI

CourseCode	Course	Category	Hours per Week				Credits
			L	T	P	Total Hours	
Theory							
23MDC601	Multidisciplinary Elective-III	MDC	3	0	0	3	3
23ME601	Theory of Machines- II	PC	3	0	0	3	3
25ME602	Additive Manufacturing	PC	3	0	0	3	3
23ME603	Industry 4.0	PC	3	0	0	3	3
23ME604	Refrigeration & Air conditioning	PC	3	0	0	3	3
23MEXXX	Professional Elective Course – VI	PE	3	0	0	3	3
23MEXXX	Professional Elective Course – VII	PE	3	0	0	3	3
Total			21	0	0	21	21
Practical							
23ME651	Theory of Machines Lab	P	0	0	2	2	1
23LP651	Live Project-II* & Industrial Visits	LP/SI	0	0	1	1	1
Total			0	0	3	3	2
Skill Enhancement Courses (SEC)							
24CS0302A/ 24CS0302B/ 24CS0302C/ 24CS0302D	Artificial Intelligence andMachine Learning/MATLAB for Engineers/ Structural Analysis using FEM-based Tools/Data Analytics Tools	SEC	0	0	2	2	1
23SS654	Professional Skills	SEC	0	0	2	2	1
Total			0	0	4	4	2
TOTAL (Theory + Practical + SEC)			**21**	**0**	**7**	**28**	**25**

L : Lecture T : Tutorials P: Practical	PC : Professional Core PE : Professional Electives MDC- Multi Disciplinary Courses P : Practical SEC : Skills Enhancement Course LP/ SI : Live Project-II/Internship

* Internship will be carried out in 4th Semester during semester break. Evaluation to be carried out in 5th semester

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – VII

Course Code	Course	Category	Hours Per Week				Credits
			L	T	P	Total Hours	
Theory							
23ME701	Engineering Metrology & Instrumentation	PC	3	0	0	3	3
25ME702	Pneumatics and Hydraulics System	PC	3	0	0	3	3
23MEXXX	Professional Elective Course – VIII	PE	3	0	0	3	3
23MEXXX	Professional Elective Course – IX	PE	3	0	0	3	3
23MEXXX	Professional Elective Course – X	PE	3	0	0	3	3
23MEXXX	Professional Elective Course – XI	PE	3	0	0	3	3
Total			18	0	0	18	18
Practical							
23ME751	Engineering Metrology & Instrumentation Laboratory	P	0	0	2	2	1
23LP751	Live Project-IV and Internship	LP/SI	0	0	2	2	1
23ME752	Minor Project	LP	0	0	4	4	4
Total			0	0	8	8	6
Skill Enhancement Courses (SEC)							
24CS0401A/24CS0401B/24CS0401C/24CS0401D	Building information modeling/PLC Programming/ FPGA for Embedded Systems/Essentials of Blockchain and IoT	SEC	0	0	2	2	1
23SS755	Aptitude & Reasoning	SEC	0	0	2	2	1
Total			0	0	4	4	2
TOTAL (Theory + Practical + SEC)			**18**	**0**	**12**	**30**	**26**

L : Lecture T : Tutorials P: Practical	PC : Professional Core PE : Professional Elective P : Practical SEC : Skills Enhancement Course LP/ SI : Live Project-II/Internship

BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) DEGREE COURSE

PROGRAM COURSE'S STRUCTURE SEMESTER WISE

SEMESTER – VIII

Course code	Course	Category	Hours per week				Credits
			L	T	P	Total Hours	
23ME851	Major Project	LP/SI	0	0	24	24	12
TOTAL			**0**	**0**	**24**	**24**	**12**

* *To be monitored at the Department Level*

L : Lecture T : Tutorials P: Practical	LP/SI : Live Project

Department Professional Elective Courses

1. Mechanical Engineering
Professional Elective Courses

	Course Code	Course	L	T	P	C
Elective I	25MEPE01	Materials Science and smart materials	3	0	0	3
	23MEPE02	Introduction to Sensors, Actuators & IoT	3	0	0	3
Elective II	23MEPE03	Programming using Python	3	0	0	3
	23MEPE04	Alternate Sources of Energy and system	3	0	0	3
Elective III	23MEPE05	Hydraulic Machine	3	0	0	3
	23MEPE06	Industrial Engineering and Operations Research	3	0	0	3
Elective IV	23MEPE07	Flexible Manufacturing System	3	0	0	3
	23MEPE08	Metallurgical Waste Management	3	0	0	3
Elective V	23MEPE09	Power Plant Engineering	3	0	0	3
	23MEPE10	Simulation Modelling of Manufacturing Systems	3	0	0	3
Elective VI	23MEPE11	Gas Dynamics and Turbo Machinery	3	0	0	3
	23MEPE12	Supply Chain Management	3	0	0	3
Elective VII	23MEPE13	Programmable Logic Control	3	0	0	3
	23MEPE14	Micro and Nano Manufacturing	3	0	0	3
Elective VIII	23MEPE15	Total Quality Management	3	0	0	3
	23MEPE16	Computer Integrated Manufacturing	3	0	0	3
Elective IX	23MEPE17	Computational Fluid Dynamics	3	0	0	3
	23MEPE18	Automobile Engineering	3	0	0	3
Elective X	23MEPE19	Composite Material	3	0	0	3
	23MEPE20	Finite Element Method	3	0	0	3
Elective XI	23MEPE21	Mechanical Vibrations	3	0	0	3
	23MEPE22	Latest Trends in Mechanical Engineering	3	0	0	3

2. Specialization in Electric Vehicle

	Course Code	Course	L	T	P	C
Elective I	25MEPE01	Materials Science and smart materials	3	0	0	3
	23MEPE02	Introduction to Sensors, Actuators & IoT	3	0	0	3
Elective II	23MEPE03	Programming using Python	3	0	0	3
	23MEPE04	Alternate Sources of Energy and system	3	0	0	3
Elective III	23MEPE05	Hydraulic Machine	3	0	0	3
	23MEPE06	Industrial Engineering and Operations Research	3	0	0	3
Elective IV	23MEPE07	Flexible Manufacturing System	3	0	0	3
	23MEEV01	Fundamentals of Electric and Hybrid vehicles Technology	3	0	0	3
Elective V	23MEEV02	Vehicle Dynamics	3	0	0	3
	23MEPE10	Simulation Modelling of Manufacturing Systems	3	0	0	3
Elective VI	23MEEV03	Vehicle Body Engineering	3	0	0	3
	23MEEV04	Automotive transmission systems	3	0	0	3
Elective VII	23MEEV05	Fuel Cells and Applications	3	0	0	3
	23MEPE13	Programmable Logic Control	3	0	0	3
Elective VIII	23MEEV06	Vehicle Electrical Power systems	3	0	0	3
	23MEEV07	Electric Vehicle Machines and Drives	3	0	0	3
Elective IX	23MEEV08	Vehicle Management And Control	3	0	0	3
	23MEEV09	Automotive Instrumentation and Control	3	0	0	3
Elective X	23MEPE19	Composite Material	3	0	0	3
	23MEEV10	EV Charging Technology	3	0	0	3
Elective XI	23MEEV11	Autonomous Vehicles	3	0	0	3
	23MEPE22	Latest Trends in Mechanical Engineering	3	0	0	3

3. Specialization in Automation and Advanced Robotics

	Course Code	Course	L	T	P	C
Elective I	25MEPE01	Materials Science and smart materials	3	0	0	3
	23MEPE02	Introduction to Sensors, Actuators & IoT	3	0	0	3
Elective II	23MEPE03	Programming using Python	3	0	0	3
	23MEPE04	Alternate Sources of Energy and system	3	0	0	3
Elective III	23MEPE05	Hydraulic Machine	3	0	0	3
	23MEPE06	Industrial Engineering and Operations Research	3	0	0	3
Elective IV	23MEAR01	Robot kinematics	3	0	0	3
	23MEAR02	Fluid power systems for industrial automation	3	0	0	3
Elective V	23MEAR03	Advanced Materials for Robotics	3	0	0	3
	23MEAR04	Simulation Modelling of Manufacturing Systems	3	0	0	3
Elective VI	23MEAR05	Microprocessor	3	0	0	3
	23MEAR06	Automation in Manufacturing	3	0	0	3
Elective VII	23MEAR07	Robot Dynamics and Control	3	0	0	3
	23MEPE13	Non Traditional Machining Techniques	3	0	0	3
Elective VIII	23MEAR08	Mobile Robotics	3	0	0	3
	23MEAR09	Automotive Control Systems	3	0	0	3
Elective IX	23MEAR10	Actuators and Drives	3	0	0	3
	23MEAR11	Automotive Instrumentation and Control	3	0	0	3
Elective X	23MEAR12	Introduction to Drones	3	0	0	3
	23MEAR13	Computational Fluid Dynamics	3	0	0	3
Elective XI	23MEAR14	Intelligent Manufacturing Systems	3	0	0	3
	23MEAR15	Optimization for Robot Modelling	3	0	0	3

4. Specialization in Artificial Intelligence (AI) and Machine Learning (ML)

	Course Code	Course	L	T	P	C
Elective I	25MEPE01	Materials Science and smart materials	3	0	0	3
	23MEPE02	Introduction to Sensors, Actuators & IoT	3	0	0	3
Elective II	23MEPE03	Programming using Python	3	0	0	3
	23MEPE04	Alternate Sources of Energy and system	3	0	0	3
Elective III	23MEPE05	Hydraulic Machine	3	0	0	3
	23MEPE06	Industrial Engineering and Operations Research	3	0	0	3
Elective IV	23MEAI 01	Robot kinematics	3	0	0	3
	23MEAI 02	Discrete Mathematics	3	0	0	3
Elective V	23MEAI 03	Introduction to Artificial Intelligence	3	0	0	3
	23MEAI 04	Soft Computing	3	0	0	3
Elective VI	23MEAI 05	Robot Dynamics and Control	3	0	0	3
	23MEAI 06	Data Structure	3	0	0	3
Elective VII	23MEAI 07	Database Management System	3	0	0	3
	23MEPE13	Programmable Logic Control	3	0	0	3
Elective VIII	23MEAI 09	Deep Learning Principles and Practices	3	0	0	3
	23MEAI 10	Mobile Robotics	3	0	0	3
Elective IX	23MEAI 11	AI in Autonomous Vehicles	3	0	0	3
	23MEAI 12	Machine Learning	3	0	0	3
Elective X	23MEAI 13	AI in Design Optimization	3	0	0	3
	23MEAI 14	Computer vision in Mechanical Engineering	3	0	0	3
Elective XI	43MEAI 15	Cognitive Learning	3	0	0	3
	23MEAI 16	Natural Language Processing	3	0	0	3

ABILITY ENHANCEMENT COURSES

Subject Code	Category	Course	L	T	P	Credits
24HS101/24HS 201	(AEC)	Communicative English	2	0	0	2
24 HIN101-I/24FLGR-I/24FLFR-I	(AEC)	Hindi/ German/French (Phase-I)	2	0	0	2
24 HIN101-II/24FLGR-II/24FLFR-II	(AEC)	Hindi/ German/French (Phase-II)	2	0	0	2
24HS151/24HS 251	(AEC)	Communicative English Laboratory	0	0	2	1

SKILL ENHANCEMENT COURSES (SEC)

Category	Course Code	Course Name	L	T	P	Credits
Technical Training						
SEC	24CS0201A/24CS0201B/24CS0201C/24CS0201D	Data Structure and A lgorithmsusing C or C++/Industry Automation Level-I/ Digital Marketing/Fundamentals of CAD for Engineers	0	0	2	1
SEC	24CS0202A/24CS0202B/24CS0202C	Introduction to SPSS Tool/Design Thinking and Augmented Virtual Reality/Programming Using Python for Engineers	0	0	2	1
SEC	24CS0301A/24CS0301B/24CS0301C/24CS0301D/24CS0301E	Wearable Technology/Big Data Analytics, Tools and Techniques/Machine Learning using Python/Industry Automation Level-II/RCC Structure Drawing Training	0	0	2	1
SEC	24CS0302A/24CS0302B/24CS0302C/24CS0302D	Artificial Intelligence andMachine Learning/MATLAB for Engineers/ Structural Analysis using FEM-based Tools/Data Analytics Tools	0	0	2	1
SEC	24CS0401A/24CS0401B/24CS0401C/24CS0401D	Building information modeling/PLC Programming/ FPGA for Embedded Systems/Essentials of Blockchain and IoT	0	0	2	1
SEC	24CS0201A/24CS0201B/24CS0201C/24CS0201D	Data Structure and A lgorithmsusing C or C++/Industry Automation Level-I/ Digital Marketing/Fundamentals of CAD for Engineers	0	0	2	1
Soft Skill						
SEC	23SS351	Effective Communication Skills	0	0	2	1
SEC	23SS452	Teamwork & Interpersonal Skills	0	0	2	1
SEC	23SS553	Presentation Skills	0	0	2	1
SEC	23SS654	Professional Skills	0	0	2	1
SEC	23AR755	Aptitude & Reasoning	0	0	2	1

Value Added Courses

Code	Category	Course	L	T	P	Credits
23ESEB101/23ESEB201	(VAC)	Environment Bioengineering	2	0	0	2
23VAC101/23VAC201	(VAC)	Environment Protection and Sustainable Development	2	0	0	2
23VAC102/23VAC202	(VAC)	Indian Constitution and Polity	2	0	0	2
23VAC103	(VAC)	Sports, Yoga and Fitness	1	0	2	2
25VAC201	VAC	Environmental Management & legislation	2	0	0	2
NOTE: 1. All the Courses are compulsory for the students 2. Students would be encouraged to enroll for NSS/NCC						

MULTI-DISCIPLINARY COURSES (MDC)

Total: 9 (3*3) Credits						
Code	Category	Course	L	T	P	C
24MDC101	(MDC-I)	Computer Based Numerical and Statistical Technique/Probability and Random Process/Biostatistics/Numerical Methods	3	0	0	3
23MDC102		Environmental Geosciences & Disaster Management	3	0	0	3
23MDC301		IPR in Business	3	0	0	3
23MDC302		Library Information Sciences & Media Literacy	3	0	0	3
23MDC401		Management Process & Organizational Behaviour	3	0	0	3
23MDC103	(MDC-II)	Photonics	3	0	0	3
23MDC104		Chemistry & Society	3	0	0	3
23MDC303		Psychology and Emotional Intelligence	3	0	0	3
23MDC304		Indian Economy	3	0	0	3
23MDC402		Creating an Entrepreneurial Mind	3	0	0	3
24MDC 501		Numerical Methods in BME/Discrete Mathematics	3	0	0	3
23MDC105	(MDC-III)	Life Sciences & Public Health	3	0	0	3
23MDC305		Electoral Literacy in India	3	0	0	3
23MDC403		Personal Financial Planning	3	0	0	3
23MDC404		Interior Design	3	0	0	3
Note						
1. These courses will be of introductory level and shall have 3 credits.						
2. Student will not be allowed to choose or repeat the courses already gone through in class XII and present in Program core and specialization.						
3. Student will have option to choose any 3 out of the pool.						
*Course shall be based on applications, tools and techniques.						

ENGINEERING MATHEMATICS-I	
Course Code: 25AS101	**Continuous Evaluation:** 30 Marks
Credits: 4	**End Semester Examination:** 70 Marks
L T P : 3 1 0	
Prerequisite: 12^{th} Mathematics	

COURSE OBJECTIVES (COs)

1. To provide students the understanding of matrix and its applications.
2. To introduce the concept of functions of several variables, Partial differentiation, and its applications.
3. To demonstrate the applications of Multiple Integrals.
4. To describe the concepts of vector calculus.
5. To illustrate the concept of convergence, divergence of sequences and series of real numbers and improper integration.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Apply the techniques of matrices to real-world mathematical and computational problems.
2. Apply the knowledge of partial differentiation in engineering problems.
3. Calculate line, surface, and volume integrals.
4. Illustrate different real-world problems related to vector calculus
5. Explain convergence behaviour of sequences and series of real numbers and improper integration.

<u>COURSE CONTENTS</u>

UNIT	COURSE CONTENTS	HOURS
UNIT-I	**Matrix:** Types of Matrices, Elementary Transformations, Inverse of a square matrix by elementary transformation, Rank of a matrix (Echelon and Normal forms), Linear Dependence & Independence of vectors, Solution of system of linear equations (AX = 0 and AX = B), Eigenvalues and Eigenvectors, Cayley Hamilton theorem. **Application domain problems**: Cryptography (Coding and Decoding), Image and Image Processing, data storage and analysis.	12
UNIT-II	Functions of several variables, Partial Derivatives, Homogenous function, Euler's theorem for homogenous functions, Deductions from Euler's theorem, Total Derivatives, Chain Rule, Composite function of two variables, Differentiation of implicit functions, Applications of Partial Derivatives- Taylor's theorem for two variables, Maxima and minima for two variables, Jacobians. **Application domain problems**: Approximations and error analysis	12
UNIT-III	**Multiple integral:** Evaluation of Double integrals, Change of Order of Integration, Double integration in polar coordinates, Change of	

	Variables, Triple integrals - Evaluation of triple integrals over a given region, Applications of Multiple Integrals – Area (Cartesian Coordinates). Beta and Gamma functions and their properties. **Application domain problems**: Centre of Mass, Moment of Inertia, Solid of revolution and Kinetic energy	12
UNIT-IV	Vector calculus: Differentiation of vectors, Scalar and vector point functions, Gradient, Divergence, Curl, Directional derivatives, Vector Integration- Line, Surface and Volume integrals, Green's Theorem, Gauss' divergence theorem and Stroke's theorem (without proof). **Application domain problems**: Equation of continuity, Equation of motion, Inverse square law of force	12
UNIT-V	Sequence & Series: Convergence, divergence and oscillation of a series, Geometric Series, General properties of series, Test of convergence – Comparison test, Integral test, Comparison of Ratios, D'Alembert's Ratio test, Cauchy root test. **Application domain problems**: Computational geometry, Image processing.	12

TEXT BOOKS

1. Grewal B.S, Higher Engineering Mathematics, Khanna Publications, 45th Edition, 2020.
2. Jain R. K., Iyengar S. R. K., Advanced Engineering Mathematics, 7th Edition, Narosa Publishing House, 2021.
3. Kreyszig. E, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons. Singapore, 2017.
4. Bali N.P., Goyal M, Advanced Engineering Mathematics, Laxmi Publications, New Delhi, 2018.

REFERENCE BOOKS

1. Bali N.P., Goyal M, Advanced Engineering Mathematics, Laxmi Publications, New Delhi, 2018.
2. Dass H. K., Advanced Engineering Mathematics, Sultan Chand Publication, Delhi, 2018.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4	CLO5
I/II	25AS 101	ENGINEERING MATHEMATICS-I	CO1	x				
			CO2		x			
			CO3			x		
			CO4				x	
			CO5					x

MATHEMATICS-I (FOR BME ONLY)	
Course Code: 25AS107	**Continuous Evaluation:** 30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 2 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To introduce the concept of Matrices and Determinants.
2. To demonstrate the concept of Differentiation.
3. To introduce the concept of Integration.
4. To create the knowledge of Differential Equations.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Develop the essential tool of matrices and determinants.
2. Apply the knowledge of differentiation in Bio-engineering.
3. Solve problems related to integration.
4. Illustrate the concepts of differential equations.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	Introduction of matrices, Types of Matrices, Operations on Matrices, Transpose of a Matrix, Symmetric and Skew- Symmetric Matrices, Elementary Operation of a Matrix, Invertible Matrices. Introduction of Determinant, Properties of Determinants, Area of a triangle, Minor and Cofactors, Adjoint and Inverse of a Matrix. **Application domain problems:** Image and Image Processing, data storage and analysis, Gene sequencing, RNA, DNA analysis.	8
UNIT-II	Introduction, Continuity, Differentiability-Chain Rule, Derivatives of implicit functions, Derivatives of Trigonometric functions and Inverse trigonometric functions, Derivatives of Exponential and Logarithmic functions. **Application domain problems:** Enabling the modeling and analysis of dynamic biological systems.	8
UNIT-III	Introduction, Elementary Properties, Integration by method of Substitution, Integration using trigonometric identities, Integration by Partial fractions, Integration by parts. **Application domain problems:** Analyzing medical data	7
UNIT-IV	Introduction, Order and Degree of Differentiation equation, Solution of first order differential equations by method of variable separable, Homogeneous, Linear differential equation, Reducible to linear differential equation, Exact differential equation. **Application domain problems:** Various biological components interact and change over time, Epidemiology	7

TEXT BOOKS

1. Srimanta Pal and Subodh C. Bhunia, Engineering Mathematics, Oxford first edition, 2015.
2. Grewal B.S, Higher Engineering Mathematics, Khanna Publications, 44th Edition, 2017.
3. Jain R. K., Iyengar S. R. K., Advanced Engineering Mathematics, 6th Edition, Narosa Publishing House, 2019.
4. Kreyszig. E, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons. Singapore, 2015.

REFERENCE BOOKS

1. Dass H. K., Advanced Engineering Mathematics, Sultan Chand Publication, Delhi, 2018.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4
I/II	25AS107	Mathematics-I (For BME only)	CO1	x			
			CO2		x		
			CO3			x	
			CO4				x

BIOLOGY (For BME only)	
Course Code: 25AS109	**Continuous Evaluation:** 30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 1 1 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To study the basic living structure and their functions.
2. To focus on different physiological processes and introduce the concept of cell signaling and their role in diseases.
3. To understand the fundamental concepts of genetics in prokaryotes and eukaryotes.
4. To learn about the various levels of organization that plants and animals have, as well as the various activities that they do.
5. To investigate biological topics using a scientific method and get well-informed findings.
6. To integrate biological and engineering knowledge.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Explain the complicated relationship between different cellular structures and their roles.
2. Employ experimental ways to solve genetic problems.
3. Explain how animals respond to changes in their environment.
4. When dealing with biological impediments and challenges, problem-solving abilities should be applied.
5. Analyse and interpret the data using appropriate biological methods.
6. Make connections between the various portions of the topics covered in the course.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	NATURE OF LIVING THINGS Definition of life, Miller's experiment, theories and evidences of origin of life, levels of biological organization, classification of living world, difference between prokaryotes and eukaryotes, Evolutionary processes: Lamarckism, Darwinism, role of mutations and isolating mechanisms, adaptive radiation.	8
UNIT-II	MOLECULAR ORGANIZATION OF CELL Difference between animal and plant cell, salient features of intracellular organelles, cell division and cell cycle. Basic idea for Cell division, Mitosis, Meiosis. Basic idea how Central Dogma of life, Introduction to major biomolecules Carbohydrates, fats and proteins.	8
UNIT-III	FUNDAMENTALS OF GENETICS Mendelian principles, pleiotropy, epistasis, linkage and crossing over, Mendel's laws - monohybrid - dihybrid inheritance- multiple alleles-structure and organization of chromosome in prokaryote and Eukaryotes. Linkage - types of linkage -crossing over and their types.	7
UNIT-IV	UNIT IV: PHYSIOLOGY	7

	Animal Physiology: Hormones and their mode of action, types of asexual and sexual reproduction, stages of embryogenesis.	

TEXT BOOKS

1. Purves et al, Life: The Science of Biology.
2. R. Dulbecco, The Design of Life.
3. Samantha Fowler, Concepts of Biology, Publisher: OpenStax.
4. J. M. Mwaniki, Fundamentals of Biology, Longhorn Publishers and Worldreader

REFERENCE BOOKS

1. Keith Wilson & John Walker, “Practical Biochemistry - Principles & Techniques”, Oxford University Press.
2. Thyaga Rajan S, Selvamurugan N, Rajesh M.P, Nazeer, Richard Thilagaraj R.A. Barathi. W.S and. Jaganathan, M.K “Biology for Engineers”, W.H. Hill, New Delhi.
3. Robert Weaver, “Molecular Biology”, MCGraw-Hill.
4. The Biomedical Engineering –Handbook, Joseph D. Bronzino, CRC press.
5. Fundamentals Of Biology -Haupt Arthur W Books Publisher: Read Books Genre: Science, ISBN: 9781406707397, 97814067073
6. Basic Concepts In Biology 6/E by Starr Cengage Learning Inc

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO 2	CLO 3	CLO 4	CLO 5	CLO 6
I	25AS109	BIOLOGY (For BME only)	CO1	x					
			CO2	x	x				
			CO3		x	x			
			CO4				x	x	
			CO5				x	x	
			CO6					x	x

QUANTUM COMPUTATION AND COMMUNICATION	
Course Code: 25AS103/25AS206	**Continuous Evaluation:** 30 Marks
Credits: 4	**End Semester Examination:** 70 Marks
L T P : 3 1 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To reinforce the classical foundations relevant to modern physics and quantum theory.
2. To introduce key experiments and principles that led to the development of quantum mechanics.
3. To develop a conceptual and mathematical understanding of quantum mechanics and its postulates.
4. To introduce the Dirac notation and operator formalism central to quantum computation.
5. To familiarize students with classical and quantum logic gates and their role in quantum algorithms.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Analyze and solve problems related to classical systems including SHM, resonance, and LCR circuits.
2. Interpret foundational experiments like black body radiation, photoelectric effect, and Compton scattering within the quantum framework.
3. Apply the uncertainty principle, Schrödinger equation, and quantum postulates to idealized systems such as the particle in a 1D box.
4. Represent quantum states and operators using Dirac notation and apply linear algebra tools such as eigenvalues and commutators.
5. Differentiate between classical and quantum logic gates and construct basic quantum circuits using standard gate sets.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	**CLASSICAL PHYSICS:** Review of Newtonian Mechanics, Simple Harmonic Motion (SHM), Differential Equation of SHM and its Solutions, Conservation of Energy. Mass-string System, Simple pendulum, LC circuit, Qualitative discussion of damped harmonic and forced harmonic motion, resonance and its applications.	10
UNIT-II	**BASICS OF QUANTUM MECHANICS:** Black body problem, Photoelectric effect and Compton scattering (conceptual), stability of atom, dual nature of light and matter, de-Broglie Hypothesis of matter waves, Phase & Group velocities, Davison-Germer experiment.	10
UNIT-III	APPLICATIONS OF QUANTUM MECHANICS: 10	10

	Uncertainty principle, application of uncertainty principle, significance of wave functions, postulates of quantum mechanics, Schrodinger time dependent and time independent equations, particle in a box (1-D infinite potential well).	
UNIT-IV	**MATHEMATICAL TOOLS OF QUANTUM COMPUTATION:** Dirac notation: properties of kets and bras, bra-ket algebra and their matrix representation, Operators and its matrix representation: Hermitian adjoint, Hermitian conjugate rules, Hermitian and skew-Hermitian, projection operators, commutators algebra, inverse and unitary operators, Eigenvalues and Eigenvectors of an operator.	15
UNIT-V	**QUANTUM COMMUNICATION:** Classical gates (AND, OR, NOT, NAND, XOR), Qubit and its physical realization, Bloch sphere, Quantum logic gates and matrix forms, Pauli Gates: X, Y, Z gates, Hadamard Gate, S and T gates, identity gate, CNOT gate, controlled-Z gate. Application of quantum gates in quantum computation.	15

TEXT BOOKS

1. David J. Griffiths, *Introduction to Quantum Mechanics*, 2nd Edition, 2004, Pearson Education.
2. Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Information*, 10th Anniversary Edition, 2010, Cambridge University Press.
3. H.C. Verma, *Concepts of Physics*, Volume 1, 2008, Bharati Bhawan Publishers.

REFERENCE BOOKS

1. Nouredine Zettili, *Quantum Mechanics: Concepts and Applications*, 2nd Edition, 2009, Wiley.
2. Eleanor Rieffel and Wolfgang Polak, *Quantum Computing: A Gentle Introduction*, 2011, MIT Press.
3. J.J. Sakurai and Jim Napolitano, *Modern Quantum Mechanics*, 2nd Edition, 2011, Cambridge University Press.
4. Albert Paul Malvino, Donald P Leach, Goutam Saha, Digital principles and applications, 7th Edition, 2011, Tata McGraw-Hill Pvt. Ltd.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4	CLO5
I/II	25AS103/25AS206	QUANTUM COMPUTATION AND COMMUNICATION	CO1	x				
			CO2	x	x			
			CO3			x		
			CO4				x	
			CO5					x

QUANTUM PHYSICS LAB	
Course Code: 25AS153/25AS256	**Continuous Evaluation:** 40 Marks
Credits: 1	**End Semester Examination:** 60 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
2. To learn the usage of electrical and optical systems for various measurements.
3. To apply the analytical techniques and graphical analysis to the experimental data.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP).
After completion of course, students would be able to:

1. Use the different measuring devices and meters to record the data with precision.
2. Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.
3. Apply the mathematical concepts/equations to obtain quantitative results.

LIST OF EXPERIMENTS

(Students are required to complete/perform any 10 experiments from the list below)

Experiment 1: To study the characteristic of LDR and finding the dark resistance.

Experiment 2: To determine the wavelength of sodium light by Newton's ring experiment.

Experiment 3: To determine the wavelength of the given laser source using standard grating.

Experiment 4: To determine Planck's constant.

Experiment 5: To study the I-V characteristics of a PN junction diode.

Experiment 6: To determine the energy band gap by four-probe method.

Experiment 7: To study the solar cell characteristic.

Experiment 8: To determine the dispersive power of a given prism.

Experiment 9: To determine the moment of inertia of the disc and rigidity modulus of the wire by torsional pendulum.

Experiment 10: e/m by J.J. Thomson

Experiment 11: Stern - Gerlach experiment

Experiment 12: Logic gates.

TEXT BOOKS

1. Chattopadhyay, D., Rakshit, P. C and Saha, B., "An advanced Course in Practical Physics", 2nd edition, Books & Allied Ltd, Calcutta, 1990.
2. Chauhan and Singh, "Advanced practical physics", Revised edition, Pragati Prakashan Meerut, 1985.

REFERENCE BOOKS

1. Thiruvadigal. J. D., Ponnusamy S. Vasuhi, P. S. and Kumar. C, "Hand Book of Practical

physics”, 5th edition, Vibrant Publication, Chennai, 2007.
2. Engineering Practical Physics, by S. Panigrahi and B. Mallick, (CENGAG Elearning).

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3
I/II	25AS153/25AS256	Quantum Physics Lab	CO1	x		
			CO2		x	
			CO3		x	x

APPLIED CHEMISTRY	
Course Code: 25AS105 /25AS208	**Continuous Evaluation:** 30 Marks
Credits: 4	**End Semester Examination:** 70 Marks
L T P : 3 1 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. The knowledge of fundamentals of water quality parameters and the treatment of water.
2. To understand the fundamental concepts of electrochemistry and corrosion.
3. To explain states of matter, phase diagram and related applications.
4. To learn various types of polymers, and to understand the basics of spectroscopy.
5. To learn an introductory idea about nanomaterials.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Identify and analyze the quality of water.
2. Demonstrate the working of electrochemical cells and batteries.
3. Explain states of matter, phase diagram, related applications.
4. Analyze the application aspects of polymers and spectroscopy.
5. Describe the properties of nanomaterials and its synthesis.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-0	**Introduction:** Atomic and molecular masses, mole concept and molar mass, percentage composition, redox reactions, Chemical and ionic equilibrium; Acid & bases.	6
UNIT-I	**Water Technology:** Reasons for hardness-units of hardness-determination of hardness and alkalinity-Water for steam generation-Boiler Troubles-Scale, Sludge formation, Boiler corrosion, Caustic Embrittlement-Internal Treatments-Softening of Hard water- Ion Exchange process -Water for drinking purposes-Purification-Sterilization and disinfection: Chlorination, Reverse Osmosis and Electro Dialysis.	10
UNIT-II	**Electrochemistry:** Nernst Law and its applications, Electrode Potential, Electrochemical cell, Concentration Cell, Electrochemical Series, Batteries and Cells; Primary Batteries and Secondary Batteries. **Corrosion:** Electrochemical theory of corrosion, Galvanic series, Types of corrosion; Differential metal corrosion, Differential aeration corrosion (Pitting and water line corrosion), Stress corrosion (caustic embrittlement in boilers), Factors affecting, metal coatings- Galvanizing and Timing, Corrosion inhibitors, protection.	16
UNIT-III	**The Phase rule:** Statement of Gibb's phase rule and explanation of the terms involved, Phase diagram of one component system-water system, Condensed phase rule, Phase diagram of two components System-Eutectic, Pb-Ag system.	8

UNIT-IV	**Polymer:** Terminologies, Classification of polymer, Preparation of special polymer-Nylon6,6, Polyethylene, Polystyrene, Teflon, Polymethyl-methacrylate, Bakelite. **UV Spectroscopy:** Lambert Beer's Law, Principles and applications of UV-Visible Molecular Absorption Spectroscopy; Chromophores, effect of conjugation on chromophores.	12
UNIT-V	**Nano Materials:** Introduction and classification (0D, 1D, 2D) with examples, size dependent properties, Top-down and Bottom-up approaches of nanomaterial synthesis. Introductory idea on synthesis of nanomaterials *via* green synthetic route.	8

TEXT BOOKS

1. Engineering Chemistry (NPTEL web-book) by B. L. Tembe, Kamaludddin, and M.M. S. Krishan.
2. Fundamentals of Molecular Spectroscopy by Banwell, Tata McGraw-Hill Education.
3. Textbook of Nanoscience and Nanotechnology, McGraw Hillw Hill Education (India) Pvt. Ltd., 2012.) Pvt. Ltd., 2012.
4. Engineering Chemistry by Jain and Jain, Dhanpat Rai Publication.
5. Engineering Chemistry by Prasanta Rath, Cenage Learning India Private Ltd., 2015.td., 2015.
6. A Textbook of Engineering Chemistry by Shashi Chawla, Dhanpat Rai & Co., 2020 & Co., 2020.
7. Inorganic Chemistry by Donald A. Tarr and Gary Miessler, Pearson India, Third Edition.
8. Molecular Spectroscopy, Ira N. Levine, John Wiley and Sons.

REFERENCE BOOKS

1. Inorganic Chemistry by W. Overton, Rounk, and Armstrong, Oxford University Press, 6^{th} edition.
2. Advanced Engineering Chemistry by M.R. Senapati, University Science Press, India.
3. A Textbook of Engineering Chemistry by S. S. Dara, 10th Edition, S. Chand & Company Ltd., New Delhi, 2003.
4. J.D. Concise Inorganic Chemistry.
5. Inorganic Chemistry, Catherine E. Housecroft and Alan G. Sharpe, 2^{nd} Edition
6. Huheey, J. E., Keiter, E. A., Keiter, R. L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4	CLO5
I/II	25AS105 /25AS208	Applied Chemistry	CO1	x				
			CO2	x	x			
			CO3			x		
			CO4				x	
			CO5					x

APPLIED CHEMISTRY LAB	
Course Code: 25AS155/25AS258	**Continuous Evaluation:** 40 Marks
Credits: 1	**End Semester Examination:** 60 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

An integrated laboratory course consists of experiments from applied chemistry and is designed:

1. To impart the knowledge and understanding of principles of measurement techniques.
2. To understand the principle involved in the synthesis of chemical compounds, and quantitative analysis.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Explain the basic concepts of measurement techniques.
2. Execute synthesis of compounds and determination quantitative analysis.

LIST OF EXPERIMENTS

(A Student is supposed to complete/perform minimum 8-10 of experiments)

1. Determination of total hardness of water by EDTA method.
2. Determination of dissolved oxygen in a sample of water.
3. Determination of percentage of available chlorine in a sample of bleaching powder.
4. Standardization of $KMnO_4$ using sodium oxalate. Determination of ferrous iron in Mohr's salt by potassium permanganate.
5. Determination of Viscosity of addition polymer by Ostwald Viscometer.
6. Determination of alkalinity of given sample.
7. Estimation of calcium in limestone.
8. Acid-Base Titration by Potentiometry.
9. Preparation of Silver/Iron nano particles.
10. Preparation of Bakelite.
11. Preparation of Urea formaldehyde resin.
12. To record UV-Spectrum of $KMnO_4$ and $K_2Cr_2O_7$.
13. Estimation of nickel in given sample solution
14. Estimation of nitrite in given sample solution.

TEXT BOOKS

1. Vogel's Textbook of Quantitative Chemical Analysis (Latest ed.), Revised by G.H. Jeffery, J. Bassett, J. Mendham & R.C. Denney, Longman Scientific & Technical, England

2. Applied Chemistry: Theory and Practice (Latest ed.), by O.P. Vermani & A.K. Narula, New Age International Publications.

REFERENCE BOOKS

1. Dara, S.S.;A text book on Experiments and Calculations in Engineering Chemistry (ninth edition); S. Chand,2003.

2. Rani, S.; Laboratory Manual on Engineering Chemistry; DhanpatRai,1998.

3. Department Laboratory Manual.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2
I/II	25AS155/25AS258	Applied Chemistry Lab	CO1	x	
			CO2		x

BASIC ELECTRICAL ENGINEERING	
Course Code:25EE101/25EE202	**Continuous Evaluation:**30 Marks
Credits: 3	**End Semester Examination:** 70 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To impart knowledge about the electrical quantities and to understand the impact of electricity in a global and societal context.
2. To introduce the fundamental concepts relevant to DC and AC circuits and network theorems.
3. To understand the concept of electrical machines in real-life applications.
4. To familiarize the sources of renewable energy and electric vehicles and their progress in recent years

COURSE LEARNING OUTCOMES (CLOs)

After completion of the course, students would be able to:

1. To apply various network laws and theorems in DC circuits.
2. To compute different AC quantities with phasor representation.
3. To realize the operation of single-phase circuits and induction motors
4. To understand the basic concept of a poly-phase system.
5. To define various renewable resources available in power generation.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	**DC Circuits** Ohm's Law and Kirchhoff's Laws, Analysis of Series, parallel, and series-parallel circuits excited by independent voltage sources, Star-delta transformation, Mesh current Analysis, Node voltage analysis, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem	9
UNIT-II	**Single-Phase A.C. Circuits** Sinusoidal signal, instantaneous and peak values, RMS and average values, crest and peak factor, Concept of phase, Analysis with phasor diagrams of R-L, R-C and R-L-C circuits; Real power, reactive power, apparent power and power factor, Resonance in series R-L-C circuit, Quality factor and Bandwidth, Introduction to earthing.	9
UNIT-III	**Electrical Machines** **A. Transformers:** Magnetic circuits, Review of laws of electromagnetism, Flux, MMF and their relation, analysis of magnetic and electric circuits, Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency, and voltage regulation. **B. Three-Phase Induction Motor:** Concept of rotating magnetic field; Principle of operation, types and constructional features, Slip and its significance; Applications of squirrel	9

	cage and slip ring motors; Torque-speed characteristics of 3-phase induction motor.	
UNIT-IV	**Poly-Phase System***:* Advantages of 3-phase system, Generation of 3-phase voltages, Voltage, current, and power in a star and delta connected systems, 3-phase balanced and unbalanced circuits, Power measurement in 3-phase circuits using the two-wattmeter method.	9
UNIT-V	**Renewable Sources:** Sources of Electrical Power, Introduction to Wind, Solar, Fuel cell, Tidal, Geothermal, Hydroelectric, Thermal-steam, diesel, gas power plants **Electric Vehicles:** What is an EV, Benefits of EVs, EV and its types: BEV, PHEV, HEV, and FCEV, EV scenario in India.	9

TEXT BOOKS

1. FundamentalofElectricCircuitsbyCharlesKAlexanderandMatthewN.O.Sadiku,TMHPublication.
2. Electrical Engineering Fundamentals by Vincent DelToro, PHIPublication.
3. Basic Electrical Engineering by V N Mittal & Arvind Mittal, TMHPublication.
4. BasicElectricalTechnologybyA.E.Fitzgerald,McGrawHillPublication.

REFERENCE BOOKS

1. KothariDPandNagrathIJ,“BasicElectricalEngineering“,TataMcGrawHill, 1991.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4	CLO5
I/II	25EE101/25EE202	BASIC ELECTRICAL ENGINEERING	CO1	x				
			CO2			x		
			CO3		x	x	x	
			CO4					x

BASIC ELECTRICAL ENGINEERING LAB	
Course Code: 23EE151/23EE252	**Continuous Evaluation:**40 Marks
Credits: 1	**End Semester Examination:** 60 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To impart basic knowledge of electrical quantities such as current, voltage, power, energy etc.
2. To familiarize students with basic circuit components and their connections.
3. To explain working principle of transformer and electrical measuring instruments such as ammeter, voltmeter, wattmeter, energy meter, digital storage oscilloscope etc.

COURSE LEARNING OUTCOMES (CLOs)

After completion of the course, students would be able to:

1. Verify fundamental laws like Ohm's Law, KCL, KVL, etc.
2. Understand the calibration of energy meter.
3. Understand open circuit and short circuit test of single-phase transformer.
4. Analyse RLC series and parallel circuits.

LIST OF EXPERIMENTS

(A Student is supposed to complete/perform minimum **10** experiments)

1. To verify Kirchhoff's voltage and Current Laws
2. To verify Superposition Theorem
3. To verify Thevenin's Theorem
4. To verify Maximum Power Transfer Theorem
5. To verify Norton's Theorem
6. To measure power and power factor in single phase AC circuit.
7. To verify Series and parallel RLC circuit
8. To conduct open circuit and short circuit test on a single-phase transformer
9. To perform Load test on single phase transformer
10. Calibration of Single Phase & Three Phase Energy Meter
11. To study Digital Storage Oscilloscope
12. To study the balanced three phase system for star and delta connected load
13. To study about earthing and their types.

TEXT BOOKS

1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru, J M Chuma, H U Ezea
2. Electrical Measurements & Measuring Instruments by E.W. Golding & F.C. Widdis
3. Electronic Measurement & Instrumentation by H.S. Kalsi
4. Electrical & Electronic Measurement & Instrumentation by A.K. Sawhney ,E. Fitzgerald, C. Kingsley and S. Umans, Electric Machinery, McGraw-Hill Co. Inc.
5. D. P. Kothari and I. J. Nagrath, Electrical Machines, Tata McGraw-Hill.

REFERENCE BOOKS

1. M.G. Say, Alternating Current Machines, Pitman Publishing.
2. Alexander S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw-Hill.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4
I/II	23EE 151/23EE 252	BASIC ELECTRICALE NGINEERING LAB	CO1	x	x		x
			CO2	x			x
			CO3	x	x	x	x

BASIC ELECTRONICS ENGINEERING	
Course Code: 25EC101/25EC202	**Continuous Evaluation:** 30 Marks
Credits: 3	**End Semester Examination:** 70 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

At the end of the course, the student will be able to:

1. Analyse the characteristics and applications of semiconductor diodes, including Zener diodes, and their role in power supply and wave-shaping circuits.
2. Understand the operation, biasing, and characteristics of BJT, and apply them in amplification and switching circuits.
3. Understand the operation, biasing, and characteristics of FETs, and apply them in amplification and switching circuits
4. Design and implement analog circuits using op-amps for integration, differentiation, and signal conditioning applications.
5. Understand and simplify digital logic expressions using Boolean algebra, and design combinational digital circuits.

COURSE LEARNING OUTCOMES (CLOs)

After completion of the course, students would be able to:

1. Understand and analyze the operation and characteristics of semiconductor diodes and their applications in rectifiers, clippers, and voltage regulators.
2. Demonstrate and evaluate the working principles, biasing, and applications of BJTs in switching and amplifier circuits.
3. Design and simulate analog electronic circuits using FET and Op-amps for real-time signal processing.
4. Comprehend and apply the fundamental concepts of digital logic, Boolean algebra, and combinational circuits.
5. Interpret electronic component datasheets, test devices using multimeters, and troubleshoot circuits effectively.

<u>COURSE CONTENTS</u>

UNIT	COURSE CONTENTS	HOURS
UNIT-I	**DIODE THEORY AND APPLICATIONS:** Overview of p-n junction diode structure, Basic idea of forward and reverse biasing in diodes, VI characteristics of p-n junction diode under various biasing conditions, Ideal diode characteristics and assumptions, Second approximation (with cut-in voltage), Third approximation (including forward resistance and reverse leakage current), Structure and working principle of Zener diode, VI characteristics of Zener diode in breakdown region, Zener diode as a voltage regulator, half and Full Wave Rectifier: Circuit diagram, operation, and waveform analysis, Calculation of average and RMS output voltage, Ripple factor and efficiency, Transformer requirements and peak inverse voltage (PIV) analysis. **Wave Shaping Circuits:** Clipping Circuits, Clamping Circuits.	9
UNIT-II	**BIPOLAR JUNCTION TRANSISTORS AND ITS BIASING:** BJT structure and	9

	working principle (NPN/PNP),CE, CB, and CC configurations: input/output characteristics and applications, BJT current and voltage relations, Switching operation of BJT: cutoff, active, and saturation regions, DC load line: operating point (Q-point) determination, Biasing methods: base bias, emitter feedback bias, collector feedback bias, voltage divider bias, Thermal runaway and stability factor	
UNIT-III	**FIELD EFFECT TRANSISTORS (FET) AND ITS BIASING:** Introduction to JFET: structure, operation, and characteristics, Comparison of BJT and FET: input impedance, noise, gain, power usage, JFET transfer and drain characteristics, pinch-off voltage, Biasing methods for JFET: self-bias, voltage-divider bias, current source bias, FET operation in ohmic and active regions, Introduction to MOSFETs: D-type and E-type structures and operation, MOSFET as a switch: operation, input/output characteristics , E-MOSFET biasing technique: self-bias, voltage-divider bias, current source bias	9
UNIT-IV	**OP-AMP: OP-AMP:** Ideal op-amp characteristics and internal block diagram, Op-amp equivalent circuit model, Comparator circuit using op-amp: zero crossing detector, Inverting and non-inverting op-amp configurations: gain expressions and phase relations, summing amplifier using op-amp (inverting and non-inverting), Differential amplifier, integrator and differentiator circuits: design and waveforms.	9
UNIT-V	**DIGITAL ELECTRONICS:** Number systems: Binary, Decimal, Octal, Hexadecimal and their conversions. Basic logic gates: AND, OR, NOT, NAND, NOR, XOR, XNOR – symbols, truth tables, logic expressions, Consensus theorem , Boolean algebra: laws, identities, and logic simplification, De Morgan's Theorems and duality principle, Transposition theorem, Consensus theorem , Universal gates and their use in implementing any logic function, Algebraic simplification using Boolean laws and Karnaugh Maps (K-Maps upto three variable), NAND and NOR based gate implementation techniques, Combinational circuits: Half adder and Full adder, Half Subtractor, Full Subtractor design and logic expressions,	9

TEXT BOOKS

1. Electronic Devices and Circuit Theory - by Rober L. Boylestad 11th Edition, Pearson Publication, 2014
2. Digital Design by M. Morris Mano, 5th Edition, Pearson Publication, 2016
3. Floyd T.L., Buchla D.L., "Electronics Fundamentals: Circuits, Devices and Applications", 8th 2010 Edition
4. Stallings, W., "Computer Organization and Architecture", 5th Ed., 2001 Pearson Education

REFERENCE BOOKS

1. Millman J., Halkias C.C., Jit S., "Electronic Devices and Circuits", Tata McGraw-Hill, 2nd 2007 Edition
2. Muthu subramanian.R, Salivahanan. S, Muraleedharan. K. A, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw - Hill, 1999.

3. Microelectronic Circuits by A. S. Sedra and Kenneth C. Smith 7th Edition, Oxford University, Press. 2017

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4	CLO5
I/II	25EC101/25EC202	BASIC ELECTRONICS ENGINEERING	CO1	✓				
			CO2		✓			
			CO3			✓		
			CO4				✓	
			CO5					✓

BASIC ELECTRONICS ENGINEERING LAB	
Course Code: 25EC151/25EC252	**Continuous Evaluation:**40 Marks
Credits: 1	**End Semester Examination:** 60 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To understand semiconductor device Characteristics.
2. To design and evaluate rectifier circuits.
3. To characterize transistor and FET operation.
4. To design and test OP-AMP circuits.
5. To demonstrate digital logic design.

COURSE LEARNING OUTCOMES (CLOs)

1. To analyze PN junction, Zener diodes, and their applications in circuits.
2. To construct and compare half-wave, full-wave, and bridge rectifiers with filters.
3. To investigate BJT (CB), JFET, and MOSFET configurations and their regions of operation.
4. To implement and verify analog circuits (voltage follower, inverting/summing amplifiers).
5. To build and validate combinational circuits (logic gates, adders) and Boolean theorems.

<u>LIST OF EXPERIMENTS</u>

1. To study and analyze the V-I characteristics of a PN junction diode in both forward and reverse bias conditions using Silicon and Germanium diodes.
2. To examine the V-I characteristics of a Zener diode in forward and reverse bias, and to observe the Zener breakdown phenomenon and its application in voltage regulation.
3. To study the output waveform of a half-wave rectifier with and without a filter capacitor, and to observe how the capacitor smooths the pulsating DC output by reducing ripple.
4. To analyze the characteristics of a full-wave center-tapped rectifier, observe its output waveform, and evaluate the effect of filter capacitors of varying values on ripple reduction and waveform smoothness.
5. To construct and test a bridge rectifier circuit, monitor its output waveform, and investigate the improvement in waveform smoothness with the use of different filter capacitor values.
6. To study the input and output characteristics of a transistor in Common Base (CB) configuration.
7. To study the output characteristics of an N-channel JFET, and to observe the behavior of the JFET in ohmic and saturation regions.
8. To study the output characteristics of an N-channel MOSFET and to analyze the MOSFET's behavior in the ohmic and saturation regions.
9. To design and analyze a voltage follower circuit using an operational amplifier (OP-AMP) and verify that the output voltage exactly follows the input voltage with a unity gain (A=1).
10. To design and verify the operation of an inverting amplifier using an OP-AMP, and to measure the output voltage for a given input voltage with a known gain, validating the relationship: $V_o=-A\cdot V_i$.
11. To design and verify the operation of a summing amplifier using an operational amplifier (OP-AMP) and to measure the output voltage for different input voltages, demonstrating linear summation with unity gain.
12. To design and verify the truth tables of basic logic gates (AND, OR, NAND, NOR, XOR, and

XNOR) using digital ICs on a breadboard.

13. To experimentally **verify the Consensus Theorem** of Boolean algebra using logic gates and validate its application in simplifying digital circuits.
14. To design and verify the working of a **half adder circuit** using basic logic gates (AND and XOR).
15. To design and verify the working of a **full adder circuit** using basic logic gates (AND, OR and XOR).

REFERENCE: LABORATORY MANUAL

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUBCODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4	CLO5
I/II	25EC151/25EC252	BASIC ELECTRONICS ENGINEERING LAB	CO1	✓				
			CO2		✓			
			CO3			✓		
			CO4				✓	
			CO5					✓

FUNDAMENTALS OF ROBOTICS & AI	
Course Code: 25ME101/25ME202	**Continuous Evaluation:**30 Marks
Credits: 3	**End Semester Examination:** 70 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

The objectives of this course are to:

1. Understand and discuss the fundamental elementary concepts of Robotics.
2. Provide insight into different types of robots.
3. Explain intelligent module for robotic motion control.
4. Educate on various path planning techniques.
5. Illustrate the working of innovative robotic devices

COURSE LEARNING OUTCOMES (CLOs)

By the end of this course, students will be able to:

1. Describe the fundamental concepts, history, and components of robotics.
2. Classify various types of robots and analyze their configurations and kinematics.
3. Explain different drive systems, end effectors, and control methods used in robotic systems.
4. Evaluate applications of robotics in industrial, medical, agricultural, and autonomous systems.
5. Demonstrate a basic understanding of Artificial Intelligence concepts relevant to robotics.

<u>COURSE CONTENTS</u>

UNIT	COURSE CONTENTS	HOURS
UNIT-I	**Introduction To Robotics:** Introduction to Robotics and Automation, laws of robot, brief history of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics market and the future prospects, advantages and disadvantages of robots.	9
UNIT-II	**Robot Anatomy And Motion Analysis:** Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Wok volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics, transformations and rotation matrix.	9
UNIT-III	**Robot Drives and End Effectors:** Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1 DoF, 2 DoF, multiple degrees of freedom robot hand, tools as end effectors, Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control.	9
UNIT-IV	**Robotics Applications: Material Handling:** Pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications, unmanned vehicles:	9

	ground, Ariel and underwater applications, robotic for computer integrated manufacturing. Types of robots: Manipulator, Legged robot, wheeled robot, aerial robots, Industrial robots, Humanoids, Robots, Autonomous robots, and Swarm robots	
UNIT-V	**Fundamentals of Artificial Intelligence:** Introduction to Artificial Intelligence: definition, goals, and brief history; basic concepts of AI: learning, reasoning, and problem-solving; knowledge representation and simple rule-based systems; overview of machine learning: supervised and unsupervised learning; role of AI in enabling intelligent behavior in robots.	9

TEXT BOOKS

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009.
2. Mikell P. Grooveret. al., "Industrial Robots - Technology, Programming and Applications",McGraw Hill, Special Edition, (2012).
3. Ganesh S Hegde, "A textbook on Industrial Robotics", University science press, 3rdedition, 2017.
4. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
5. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence",McGraw Hill,1987. https://www.robots.com/applications.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
I/II	25ME101/ 25ME202	FUNDAMENTALS OF ROBOTICS & AI	CO1	✓				
			CO2	✓				
			CO3		✓			
			CO4			✓		✓
			CO5				✓	

DESIGN THINKING AND ENGINEERING PRACTICES LAB	
Course Code: 25ME151/25ME252	**Continuous Evaluation:**40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To introduce students to the fundamentals of design thinking and its application in engineering problem-solving.
2. To understandworkshop tools used in carpentry, welding, sheet metal, and machining
3. To provide hands-on experience in basic engineering practices such as welding, carpentry, machining, and sheet metal work.
4. To foster creativity, teamwork, and practical skills through physical prototyping.
5. To understand safety, tools, and standard practices involved in common engineering operations.

COURSE LEARNING OUTCOMES (CLOs)

Upon successful completion of the course the students will be able to

1. Apply design thinking principles to simple engineering problems
2. Operate basic workshop tools used in carpentry, welding, sheet metal, and machining
3. Demonstrate hands-on skills through the fabrication of simple mechanical components
4. Work effectively as a team member in engineering practice sessions
5. Apply workshop safety protocols and proper tool handling procedures

LIST OF EXPERIMENTS

1. Introduction to Design Thinking : Empathize, Define, Ideate, Prototype, Test – with engineering case examples
2. Safety and Workshop Orientation : Personal Protective Equipment (PPE), safety signs, hazard zones, and tool use policies
3. Carpentry Practice : Sawing, chiselling, planning, drilling – make a dovetail or T-joint
4. Welding Practice : Arc welding (butt & lap joints), electrode selection, safety protocols
5. Sheet Metal Work : Cutting, bending, rivet joining, tray/box making
6. Machining Practice : Lathe operation (facing, turning), drilling, tapping
7. Mini Project (Design + Fabrication) : Students form teams to design and fabricate a small product using at least 2 workshop processes
8. Presentation & Evaluation : Final demonstration of project, reflection on design thinking, peer review

TEXT BOOKS

1. K.C. John*"Mechanical Workshop Practice"*, PHI Learning Pvt. Ltd., Latest Edition. Covers carpentry, welding, fitting, machining, and safety practices.
2. Sanjay Moizuddi*"Introduction to Design Thinking"*, Pearson Education, 1st Edition. Introduces the design thinking process with real-world applications in engineering.
3. Raghavendra, K. and Krishnamurthy, L.*"Engineering Workshop Practice"*, PHI Learning Pvt. Ltd.
   A practical reference for workshop tools and exercises (wood, metal, welding).
4. P. Kannaiah& K.L. Narayana*"Workshop Manual"*, Scitech Publications.

Detailed procedural steps for carpentry, sheet metal, fitting, and machining.

5. **IDEO.org** *"The Field Guide to Human-Centered Design"*, IDEO Press (Free PDF available online) A hands-on reference for applying empathy, prototyping, and iteration in design thinking.
6. **Tapan P. Bagchi** *"Engineering Design"*, Wiley India Pvt. Ltd. Explores the fundamentals of creative problem-solving and product design.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
I/II	25ME151/25ME252	DESIGN THINKING AND ENGINEERING PRACTICES LAB	CO1	✓				
			CO2		✓			
			CO3			✓		
			CO4				✓	
			CO5					✓

FUNDAMENTALS OF COMPUTER & C PROGRAMMING	
Course Code: 25CS101/25CS202	**Continuous Evaluation:** 30 Marks
Credits: 3	**End Semester Examination:** 70 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To familiarize and understand the basic concepts of digital computers and computer programming.
2. To impart adequate knowledge on the need of programming languages and problem solving techniques.
3. To analyze and construct effective algorithms.
4. To develop problem solving ability using programming.
5. To employ good programming practices such as incremental development, data integrity checking and adherence to style guidelines.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Understand the fundamental concepts of computers, both hardware and software.
2. Learn and understand the major system software that help in developing an application.
3. Apply and analyse the basic programming constructs in context of C programming language.
4. Analyse and evaluate the derived datatypes (array) and the operations that can be performed on them, along with the concept of modularity through functions
5. Create and manipulate a database or data storage through files.
6. Learn a programming approach to solve problems.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	INTRODUCTION OF COMPUTER SYSTEM Anatomy of a digital Computer, Different Units of Computer, System, Hardware & Software, Classification of Computer Systems, Number systems, Operating System: Definition, working & its functions, Basic concepts of Computer Networks, Network Topologies.	9
UNIT-II	INTRODUCTION TO SYSTEM SOFTWARE Programming language- Definition, types; Syntax & Semantics, Type of programming errors, Assembler, Linker, Loader, Compiler, Interpreter, debuggers, Algorithms, flowcharts and their symbols.	9
UNIT-III	BASICS OF ‘C’ LANGUAGE C Fundamentals, Basic data types, variables and scope, storage classes, operators and expressions, formatted input/ output, expressions, selection statements, loops and their applications.	9
UNIT-IV	ARRAY & FUNCTION Arrays, functions, recursive functions, pointers and arrays. Strings literals, arrays of strings; applications. Storage Classes and Pre-processor Directives.	9

UNIT-V	**STRUCTURE & FILE SYSTEM** Structures, Declaring a Structure, Accessing Structure Elements, Storing Structure elements, Array of Structures, Unions and Enumerations, Dynamic memory allocation. File Input/Output, Data Organization, File Operations, Opening a File, Reading from a File, Closing the File, Writing to a File, File Opening Modes.	9

TEXT BOOKS

1. The C Programming Language by Dennis M Ritchie, Brian W. Kernigham, 1988, PHI.
2. Computer System & Programming in C by S Kumar & S Jain, Nano Edge Publications, Meerut.
3. Fundamentals of Computing and C Programming, R. B. Patel, Khanna Publications, 2014, New Delhi.
4. Let Us C, YashwantKanetkar, 20th Edition, BPB Publications, 2024.
5. Computer Fundamentals and Programming in C, ReemaTheraja, 2nd Edition, Oxford, 2016.

OPEN EDUCATIONAL RESOURCES

1. **Programming in C:** https://en.wikibooks.org/wiki/C_Programming
2. **C Programming and Data Structures:** https://nptel.ac.in/courses/106/105/106105171/
3. **Harvard's CS50 (Introduction to Computer Science):** https://cs50.harvard.edu/x/

REFERENCE BOOKS

1. Information technology, Dennis P. Curtin, Kim Foley, KunalSen, Cathleen Morin, 1998, TMH.
2. Theory and problem of programming with C, Byron C Gottfried, TMH.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO 2	CLO 3	CLO4	CLO 5	CLO 6
I/II	25CS101/25CS202	FUNDAMENTALS OF COMPUTER & C PROGRAMMING	CO1	x	x				
			CO2		x	x			
			CO3			x	x		
			CO4					x	
			CO5						x

C PROGRAMMING LAB	
Course Code: 25CS151/25CS252	**Continuous Evaluation:** 40 Marks
Credits: 1	**End Semester Examination:** 60 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To develop problem solving ability using programming.
2. To impart adequate knowledge on the need of programming languages and problem solving techniques.
3. To develop a methodological way of problem solving.
4. To learn a programming approach to solve problems.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in alignment with National Education Policy (NEP). After completion of course, students would be able to:

1. Understand the Typical C Program Development Environment, compiling, debugging, Linking and executing.
2. Introduction to C Programming using Control Statements and Repetition Statement.
3. Apply and practice logical formulations to solve some simple problems leading to specific applications.
4. Design effectively the required programming components that efficiently solve computing problems in the real world.
5. Employ good programming practices such as incremental development, data integrity checking and adherence to style guidelines.

<u>LIST OF EXPERIMENTS</u>

1. Implement a C program to determine the largest of three numbers using the if-else construct
2. Implement a program to find the largest among ten numbers using for-statement.
3. Design a program to compute average height by gender based on inputs of sex code and height.
4. Implement a function-based program to find the roots of a quadratic equation using a **switch-case** construct.
5. Implement logic to find the largest and second largest in an array of 50 integers.
6. Implement matrix multiplication using nested loops and two-dimensional array.
7. Implement a sorting algorithm to arrange a list of numbers in ascending order.
8. Develop an ATM simulation system that supports balance, deposit, withdraw options using switch-case.
9. Implement a recursive program to generate Fibonacci series.
10. Implement a program to swap two numbers using both call by value and call by reference.
11. Implement string operations to check whether a given string is a palindrome.
12. Develop a structure-based program to manage student records with add, view, and update functionality.

13. Implement file handling operations to create a file and write user input to it.
14. Write a program which manipulates structures into files (write, read, and update records).
15. Mini Project –Write a program to develop a small application using functions, arrays, structures, and file handling. Choose one of the following:
    i) Student Record Management System
    ii) Quiz Game
    iii) Hospital Patient Entry System
    iv) Railway Reservation System

TEXT BOOKS

1. C Programming Language by Dennis M Ritchie, Brian W. Kernigham, 2nd Edition, Pearson.
2. Computer System & Programming in C by S Kumar & S Jain, Nano Edge Publications, Meerut.
3. Fundamentals of Computing and C Programming, R. B. Patel, Khanna Publications, 2010, New Delhi.

REFERENCE BOOKS

1. Let Us C, Yashwant Kanetkar, 20th Edition, BPB Publications.
2. Computer Fundamentals and Programming in C, Reema Theraja, Oxford
3. Information technology, Dennis P. Curtin, Kim Foley, Kunal Sen, Cathleen Morin, 1998, TMH.

OPEN EDUCATIONAL RESOURCES

1. MIT Open Course ware: https://ocw.mit.edu/courses/6-087-practical- programming-in-c-january-iap-2010/resources/mit6_087iap10_lec01/

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO 2	CLO 3	CLO4	CLO 5
I/II	25CS151 /25CS252	C PROGRAMMING LAB	CO1	√				
			CO2		√	√		
			CO3				√	
			CO4					√

MAPPED SDGs: SDG-4, SDG-9

COMMUNICATIVE ENGLISH	
Course Code: 25HS101/25HS202	**Continuous Evaluation:**30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 2 0 0	
Prerequisite: Basic Knowledge of English	

COURSE OBJECTIVES (COs)

1. To prepare the students for their career which will require them to listen, read, speak, and write in English both for their professional as well as interpersonal communication
2. To write clear, coherent, and well-organized texts, such as emails, essays, reports, and other forms of written communication.
3. To enable students to identify the common mistakes made by most learners of English and not make those errors both in their writing and speaking.
4. To enhance student's ability to understand spoken English in various contexts, including conversations, lectures, and media.
5. To enhance student's vocabulary and master key grammatical structures, enabling them to communicate more effectively and accurately.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Recall and identify English vocabulary words and grammatical structures.
2. Analyse the structure and organization of written texts, identifying the introduction, body, and conclusion.
3. Examine how the use of specific language techniques impacts the effectiveness of communication.
4. Assess and critique public speeches and presentations based on clarity, coherence, and persuasiveness.
5. Evaluate one's own language skills and identify areas for improvement.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	**Introduction to Communication** Elements and Process of Communication, Types and Barriers to Communications, Grice Conversational Maxims and Cooperative Principles, Verbal and non-verbal communication, Body Language: Proxemics, Chronemics, and Haptics, Identifying and rectifying common errors: Types of Sentences (Statements, interrogative, exclamatory, Optative, and imperative, Wh/How-questions, question-tags), Basic Grammar: - Articles, Prepositions, Cliches, Collocations, and Punctuations, Case studies based on Communication Skills https://pressbooks.bccampus.ca/technicalwriting/chapter/casestudy-costpoorcommunication/	6
UNIT-II	**Workplace Communication** Communication Challenges in a Culturally Diverse Workplace; Ethics in Communication, Bias-free communication, Effective Business Presentations: Importance in workplace communication; Planning,	6

	Preparing, Organizing, Rehearsing, and Delivering Oral presentations, Handling Questions; and PowerPoint Presentation, Case Studies based on communication challenges in the workplace	
UNIT-III	**Effective Writing** Paragraph Writing: Topic Sentence, Guided composition, Free-writing, Reading comprehension practice: Technical and General text, use of different techniques (skimming and scanning), Selection of Words; Coherence and Cohesion, Use of discourse markers concerning technical writing, Case Studies based on technical writing skills	6
UNIT-IV	**Business Writing at Work** Cover Letters and Applications, Writing notices and circulars, Email Writing and Memorandum, Writing reports	6

TEXTBOOKS

1. English Grammar in Use. Raymond Murphy. Cambridge UP.4th Edition.
2. Business Communication by Carol M Lehman, Debbie D Dufrene, and Mala Sinha. Cengage Learning. 2nd Edition.
3. A Textbook of English Phonetics for Indian Students by T. Balasubramanian [Macmillan]
4. Soft Skills: Key to Success in Workplace and Life by Meenakshi Raman and Shalini Upadhyay. Cengage Learning. 2018 Edition.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO 2	CLO 3	CLO 4	CLO 5
I/II	25HS101/25HS202	COMMUNICATIVE ENGLISH	CO1	✓	✓	✓		
			CO2		✓		✓	
			CO3			✓		
			CO4				✓	✓
			CO5					✓

COMMUNICATIVE ENGLISH LAB	
Course Code: 25HS151/25HS252	**Continuous Evaluation:** 40 Marks
Credits: 1	**End Semester Examination:** 60 Marks
L T P : 0 0 2	
Prerequisite: Basic Knowledge of English	

COURSE OBJECTIVES (COs)

1. To prepare the students for their career which will require them to listen to, read, speak, and write in English both for their professional as well as interpersonal communication
2. To empower the students to improve both abilities to communicate and their linguistic
3. To increase their competence and boost their confidence.
4. To enable the students to properly communicate and express themselves in writing.
5. To enable students to identify the common mistakes made by most learners of English and not make those errors both in their writing and speaking.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Summarize conversations, demonstrating understanding of the content.
2. Apply communication strategies to maintain conversations and express ideas clearly.
3. Critique and assess various spoken interactions to identify strengths and areas for improvement in communication.
4. Create engaging dialogues or role-plays that demonstrate real-life communicative scenarios.
5. Develop and present persuasive arguments or opinions on various topics in English.

LIST OF ACTIVITIES

UNIT	COURSE CONTENTS	HOURS
UNIT-I	• Listening and Speaking • Accent in speech (British and American) • Practicing Sounds of English: Stress and Intonation Patterns	4
UNIT-II	• Role-play • Extempore • JAM (Just a minute)	4
UNIT-III	• Presentations • Interview Simulations • Telephone Etiquettes	4

UNIT-IV	• Formal speech- Welcome Speech and Vote of thanks • Public Speaking and Rhetoric • Group Discussions and Debates	4

TEXT BOOKS

1. English Grammar in Use. Raymond Murphy. Cambridge UP.4th Edition.
2. Business Communication by Carol M Lehman, Debbie D Dufrene and Mala Sinha. Cengage Learning. 2nd Edition.
3. A Textbook of English Phonetics for Indian Students by T. Balasubramanian [MACMILLAN]
4. Soft Skills: Key to Success in Workplace and Life by Meenakshi Raman and Shalini Upadhyay. Cengage Learning. 2018 Edition.

REFERENCE BOOKS

1. Technical Communication, Principle and Practice by Meenakshi Raman &Sangeeta Sharma, Oxford University Press.
2. Communication skill by Sanjay Kumar &PuspaLata, Oxford University Press. 2nd Edition.
3. Business Communication Today by Courtland L Bovee and Thill, Pearson

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OBJECTIVES (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO 2	CLO 3	CLO 4	CLO 5
I/II	25HS151 /25HS252	COMMUNICATIVE ENGLISH LAB	CO1	✓	✓	✓		
			CO2		✓		✓	
			CO3			✓	✓	
			CO4				✓	
			CO5					✓

ENGINEERING GRAPHICS & DESIGN LAB	
Course Code: 25ME153/25ME254	**Continuous Evaluation:** 40 Marks
Credits: 1	**End Semester Examination:**60 Marks
L T P : 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (COs)

1. To draw orthographic projections of lines, planes and solids.
2. To construct isometric scale, isometric projections and views.
3. To draw sections of solids including cylinders, cones, prisms and pyramids.
4. To draw projections of lines, planes, solids, isometric projections

COURSE LEARNING OUTCOMES (CLOs)

Once the course is completed, the students will be able to

1. Understand orthographic projections of points and lines in any position through Auto CAD.
2. Imagine and convert isometric view in to orthographic projections and vice versa.
3. Understand the simple machine components and draw its projections

<u>LIST OF EXPERIMENTS</u>

UNIT	COURSE CONTENTS	HOURS
UNIT-I	INTRODUCTION TO ENGINEERING GRAPHICS AND AUTOCAD Principles of Engineering Graphics and its significance - Usage of drawing instruments -Lettering and Dimensioning Standards - The concepts of Computer Aided Drafting for Engineering Drawing - Introduction to AutoCAD software - AutoCAD commands, tools and its usage - Geometrical Constructions	3
UNIT-II	ORTHOGRAPHIC PROJECTIONS Orthographic Projections - First angle projections - Visualization concepts and principles - Layout of views - Conversion of pictorial diagram into orthographic projections	3
UNIT-III	PROJECTION OF PLANES AND SOLIDS Projections of Planes (polygonal and circular surfaces) inclined to the HP only - Projection of simple solids like Prisms, Pyramids, Cylinders, and Cones (Axis inclined to the HP only) by change of position method. .	3
UNIT-IV	SECTIONS OF SOLIDS AND DEVELOPMENT OF SURFACES Sectioning of Simple solids in a simple vertical position using a cutting plane inclined to the HP only, and obtaining the true shape of the section - Development of the lateral surfaces of simple solids like Prisms, Pyramids, Cylinders, and Cones.	3
UNIT-V	ISOMETRIC PROJECTIONS AND CAD APPLICATIONS Principles of Isometric projections - Isometric scale and view -	3

	Isometric view of simple solids (Prisms, Pyramids, Cylinders, and Cones) - Combination of two solids in simple vertical positions - Applications of CAD software in drafting real-world scenarios.	

TEXT BOOKS:

1. Engineering Drawing - N.D. Bhatt & V.M. Panchal, Charotar Publishing House, Gujarat.
2. Computer Aided Engineering Drawing S. Trymbaka Murthy, 4th Ed, University Press
3. Engineering Drawing by N. S. Parthasarathy and Vela Murali Oxford University Press

REFERENCE BOOKS:

1. Engineering Graphics - K.R. Gopala krishna, Subash Publishers Bangalore.
2. Graphics for Design and Production-Luzadder Warren J., Duff John M., Eastern Economy Edition, Prentice-Hall of India Pvt. Ltd.,New Delhi.
3. Computer Aided Engineering drawing, Prof. M. H. Annaiah, New Age International Publisher

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO2	CLO3
I/II	25ME153/25ME254	ENGINEERING GRAPHICS & DESIGN LAB	CO1	√		
			CO2		√	
			CO3			√
			CO4			√

HINDI -I	
Course Code:25HIN101/25HIN202	Continuous Evaluation: 30 Marks
Credits: 2	End Semester Examination: 70 Marks
L T P : 2 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

हिन्दी विषय के प्रश्नपत्र की सामग्री में ज्ञान तथा शिक्षा के बदलते परिदृश्य को ध्यान में रखा गया है।हिन्दी के भक्तिकाल, रीतिकाल और आधुनिककाल के कवियों की कविताओं को पाठ्यक्रम में शामिल किया है | व्याकरण की विभिन्न कोटियों तथा भाषा के सम्प्रेषण से हिन्दी का प्रचार-प्रसार होगा।संचार कौशल के द्वारा छात्रों का ज्ञान परिमार्जित होगा।साहित्येतर छात्रों के ज्ञानवर्धन, भाषायीक्षमता एवम् अभिवृद्धि भी इस पाठ्यक्रम का लक्ष्य है।

COURSE LEARNING OUTCOMES (CLOs)

पाठ्यक्रमपरिणाम

1.Knowledge Outcome

ज्ञानकापरिणाम

At the end of the course, the student should be able to

पाठ्यक्रम केअंत में छात्र सक्षम होना चाहिए

1. -हिन्दी क़े प्रमुख कवि जो पाठ्यक्रम में शामिल है ,उनकी कविताओं की व्याख्या और काव्यगत विशेषताओं को छात्र समझेंगे।
2. छात्रों को काव्य में रस ,अलंकार और छन्द का ज्ञान प्राप्त होगा|
3. -व्याकरण के अध्ययन से छात्रों को भाषा बोलने, लिखने और पढने में सहायता प्राप्त होगी।

2.Skill Outcome

कौशल का परिणाम

At the end of the course, the student should be able to

पाठ्यक्रम केअंत में छात्रसक्षम होना चाहिए

1. -हिंदी कवियों व उनकी कविताओं से परिचित हो जाएंगे।
2. छात्र दोहे और कविता समझने में सक्षम होंगे।
3. -व्याकरण के ज्ञान के साथ– साथ शब्दों के उच्चारण के बोध से अवगत होंगे।

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	इस इकाई में हिंदी भक्तिकाल के प्रमुख कविकबीरदास हैं। कबीरदास -कबीरदास के दोहे 5 दोहे	8
UNIT-II	इस इकाई में हिंदी रीतिकाल के प्रमुख कवि बिहारीलाल हैं। बिहारीलाल- बिहारीलाल के दोहे 5दोहे	7
UNIT-III	इस इकाई में हिंदी आधुनिककाल के प्रमुख कवि माखनलाल चतुर्वेदीहैं। माखनलाल चतुर्वेदी (पुष्पकीअभिलाषा) कविता	7

UNIT-IV	यह इकाई संचार कौशल से सम्बन्धित है. इसमें (i)हिंदी के प्रमुख मुहावरे और लोकोक्तियाँ (ii) आत्मपरिचय (self-introduction), साक्षात्कारकौशल (interview skills), कार्यक्रमसंचालन/मंचप्रबंधन (event management)	8

METHODOLOGY पद्धति

- कक्षाव्याख्यान

-व्याकरण के माध्यम से हिंदी शब्दों का उच्चारण व लेखन काअभ्यास किया जाएगा|

-समय-समय पर छात्रों को प्रदत्तकार्य दिया जाएगा|

- साप्ताहिकप्रश्नावली|

REFERENCE BOOKS/ TEXT BOOKS
आवश्यक पुस्तकें और सामग्री

1. -कबीरग्रन्थावली ,संपादक-श्यामसुन्दरदास ,काशीनागरी प्रचारिणी सभा|
2. बिहारीसतसई ,साहित्यसंस्थान प्रयाग|
3. -भाषाविज्ञान ,डॉ .भोलानाथ तिवारी, किताब महल इलाहाबाद|
4. -हिंदीव्याकरण ,कामताप्रसादगुरु ,प्रभातप्रकाशनदिल्ली

GERMAN-I	
Course Code:25FLGR101	**Continuous Evaluation:** 30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 2 0 0	
Prerequisite: Basics of English Language	

COURSE OBJECTIVES (COs)

The objective of this course is to impart basic knowledge of German language to the students. The course intends to grow the ability of verbal and written communication. Overall, the objective is to facilitate comprehension of daily life contexts in German, both oral as well as written.

1. To develop oral and written skills of understanding, expressing and exchanging information in German language.
2. To develop awareness of the nature of language and language learning.
3. To develop the ability to construct sentences and frame questions.
4. To provide German language as a competitive edge in career choices.
5. To know some of the aspects of the culture of the countries where German language is spoken.

COURSE LEARNING OUTCOMES (CLOs)

After completion of the course the students will have the ability to:

1. Read and write short, simple texts.
2. Understand and take part in short, simple conversations using the skills acquired.
3. Know some aspects of the culture of the countries where the German language is spoken.
4. Read a text and/or e-mail during any employment.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	- Informationen über Deutschland - Buchstaben, die Aussprache, Wochentage, Monate - Begrüßung, Wie geht's? , sich vorstellen, Zahlen, W-Familie	8
UNIT-II	- Über Personen sprechen (Name, Herkunft, Adresse, Telefonnummer, Alter, Beruf, Familie), - Länder und Sprachen, Berufe, Satzstruktur, Familienmitglieder, Farben, Wetter - Personalpronomen, Konjugation von Verben (sein, haben, heißen, wohnen, kommen, machen, lernen, arbeiten, studieren)	8
UNIT-III	- Nomen (Genus, Singular-Plural), Bestimmter Artikel, Unbestimmter Artikel,Negation, W-Frage, Ja-Nein- Frage - Über Sachen sprechen - Sachen des Alltagslebens(Obst und Gemüse,	7

	Schulsachen), Haushaltswaren, Adjektive	
UNIT-IV	- Akkusativ, Artikel und Personalpronomen im Akkusativ - Unregelmäßige Verben - Kleidung, Lebensmittel Leseverstehen.	8

TEXT BOOKS

1. Netzwerk Neu A1 (Kursbuch+Arbeitsbuch)by StefanieDengler, et al.Ernst Klett Sprachen., 2019.

OPEN EDUCATIONAL RESOURCES

2. **Website for additional materials:**https://www.nthuleen.com/teach.html

REFERENCE BOOKS

1. Studio D A1, Hermann Funk, Christina Kuhn, Silke Demme, 2010, Cornlesen.
2. Einfach Grammatik: Übungsgrammatik Deutsch A1 bis B1, Paul Rusch, Helen Schmitz, 2012, Langenscheidt.
3. Berliner Platz - neu: Lehr- und Arbeitsbuch, Christiane Lemcke, Lutz Rohrmann, Theo Scherling, 2009, Klett Sprachen.
4. Tangram aktuell 1: A1, Rosa-MariaDallapiaza, Eduard von Jan, Sabine Dinsel, 1998, Hueber Verlag.
5. Lernziel Deutsch: Deutsch als Fremdsprache, Teil 1, Wolfgang Hieber, 1984, Max Hueber Verlag

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4
I	25FLGR101	**GERMAN-I**	CO1	√	√		
			CO2	√			
			CO3		√		
			CO4				√
			CO5			√	

FRENCH-1	
Course Code: 25FLFR101	**Continuous Evaluation:** 30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 2 0 0	
Prerequisite: Basics of English Language	

COURSE OBJECTIVES (COs)

1. To develop the skills to construct short and simple sentences.
2. To prepare the students to identify themselves with the culture of the Francophone world.
3. To develop in students a good degree of understanding of syntactic, lexical, grammatical and stylistic features of the French language.
4. To demonstrate differences and diversity of the French speaking world with their own

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of the course, students would be able to:

1. Speak themselves in French used in daily conversations.
2. Explain cultural artefacts, practices and perspectives of the French speaking world.
3. Apply linguistic knowledge to analyse a simple text, identifying its salient features, and thus express themselves effectively in French.
4. Contrast culture of the French speaking world with their own, and hence demonstrate an increased awareness towards its key practices and perspectives.

COURSE CONTENTS

UNIT	Unités	Objectifs de Communication	Grammaire	Lexique	Heures
UNIT-I	La Salutation et l'Introduction	Saluer. Entrer en Contact. S'Excuser. Remercier. Se Présenter/Présenter Quelqu'un.	Pronoms Personnels Sujets. L'Alphabet. Les Articles Indéfinis. Les Verbes en -ER au Présent.	Salutations, Les Nombres. Les Objets de la Classe. La Nationalité.	8
UNIT-II	On Partage des Renseignements	Demander de Se Présenter. Donner des Renseignements Personnels.	Etre et Avoir au Présent. Les Verbes en -ER au Présent. Adjectifs de Nationalités. L'Interrogation.	Adjectifs de Nationalité, Métiers et Secteurs Professionnels, Goûts et Intérêts	8

UNIT-III	Ma Ville et Mon Quartier	Décrire et Qualifier Ville ou Quartier. Localiser. Demander et Donner Directions.	Verbe Vivre. Articles Définis (Le, la, les). Il y a/ Il n'y a pas. Prépositions. Adjectifs Qualificatifs. Impératif.	Prépositions de lieux. Vocabulaire des Sites. Etablissements et Service de Ville.	7
UNIT-IV	Mes Intérêts et Goûts	Parler de Ses Goûts et de Ses Loisirs. Donner Son Impression sur le Caractère de Quelqu'un.	Présent des Verbes en -ER, et du Verbe Faire. Négation, Adjectifs Possessifs.	Avoir l'air. Loisirs. L'Expression des Goûts. Faire du/ de la. Ma Famille.	7

TEXT BOOKS

1. Version Originale 1, Livre de l'élève: Denyer M. & Agustin GarmendiaA. & Olivieri M L L., éd. Maisons des Langues, Paris. 2013.

REFERENCE BOOKS

1. Alter Ego 1, Livre d'élève, Berthet A. & Hugo C. & Kizirian M. V. &Sampsonis B. & Waendendries M., éd Hachette, Paris, 2006.
2. Connexions 1, Loiseau Y. & Mérieux R., éd. Didier, Paris, 2004.
3. Le Nouveau Sans Frontiers, Vol. 1, P. Dominique, J. Girardet et al,CLE International, Paris, 2013.

Le Robert & Nathan Conjugation, Paperback, Le Robert Nathan

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4
I	25FLFR101	FRENCH-I	CO1	√		√	
			CO2		√		√
			CO3			√	
			CO4				√

ENVIRONMENTAL BIOENGINEERING	
Course Code:25ESEB101/25ESEB202	**Continuous Evaluation:**30 Marks
Credits: 3	**End Semester Examination:** 70 Marks
L T P : 3 0 0	
Prerequisite: Nil	

Course Objectives (COs) - The Course is designed with the following objectives:

1. To provide a comprehensive understanding of the relationship between humans and the environment.
2. Aims to introduce students to the different components of the environment.
3. To develop the understanding of pollution, its causes, and their effects
4. To familiarize the students with the different biological concepts. Including artificial intelligence and its applications.

Course Learning Outcomes (CLOs) –The Syllabus has been prepared in accordance with the NEP-2020 and based on the UGC curriculum framework. Upon completion of this course, learners will be able to:

1. Analyse the environmental pollution and sensitize themselves to adverse health impacts of pollution.
2. Demonstrate to safeguard the Earth's environment and its resources.
3. Explain sustainable development, its goals, challenges, and global strategies.
4. Improve biological concepts using an engineering approach.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	**Human and Environment** Introduction to earth environment, Scope and importance. Components of the environment: Lithosphere, Hydrosphere, Biosphere, Atmosphere. The man- environment interaction, Population growth and natural resource exploitation, Industrial revolution, and its impact on the environment. Understanding of pollutant and pollution; Types of Pollution, Air pollution: Water pollution, Soil pollution and solid waste, Noise pollution, Thermal pollution and their impact on human health.	8
UNIT-II	**Natural Resources, Sustainable Development & Sustainable living** Overview of natural resources, Classification of natural resources, Resources: Forests, wetlands, Status and challenges. Water resources: Types of water resources, issues and challenges; Soil and mineral resources, Energy resources: renewable and non-renewable sources of energy. Biodiversity and its distribution, Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges, and strategies for SDGs. Ways to live in sustainable manner- Conservation of energy, water at home, plantation, waste segregation, kitchen	8

	gardening.	
UNIT-III	**Introduction of Bioengineering:** Significance of biology, fundamental similarities, and differences between science and engineering- humans as the best machines, brain as a computer, comparison between eye camera, **Biomolecules**: molecules of the life –monomeric unit and polymeric structure, carbohydrates, proteins; nucleotides and lipids. Bio-engineering introduction and current status in Agriculture, Medicine (vaccine and biosensors) enzyme technology, and environment, and the role of artificial intelligence and robotics in human health monitoring.	7
UNIT-IV	**Bioengineering in Environment Protection:** What is environmental bioengineering? Applications of bioengineering in the environment Protection. Global environmental problems and bioengineering approaches for their management. Sewage treatment, bio fertilizers, biofuels, bioreactors, bioremediation, and bioengineering for biomedical waste management. Role of artificial intelligence in handling biomedical waste	7

TEXT BOOKS:

1. Masters, G. M., &Ela, W. P. (2008). Introduction to environmental engineering and science Englewood Cliffs, NJ: Prentice Hall.
2. Jackson, A. R., & Jackson, J. M. (2000). Environmental Science: The Natural Environment and Human Impact. Pearson Education.
3. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press
4. Environmental Studies for Undergraduate Courses by ErachBharucha, UGC New Delhi
5. Biology: a Gopal approach Campbell, N.A Reece, J.B Urry, Lisa; Cain M.L Wasserman, S.A Minorsky, P. V Jackson, R. B Person Education ltd.

REFERENCE BOOKS:

1. A.K De Environmental Chemistry New age Publisher, 2016.
2. "Ecology & Environment" P D Sharma, Rastogi Publications, 2009.
3. www.ipcc.org; https://www.ipcc.ch/report/sixth-assessment-report-cycle/.
4. Central Pollution Control Board Web page for various pollution standards. https://cpcb.nic.in/ standards.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO 2	CLO 3	CLO 4
I/II	25ESEB101/25ESEB202	**ENVIRONMENTAL BIOENGINEERING**	CO1	√			
			CO2		√		
			CO3			√	
			CO4				√

INDIAN CONSTITUTION & POLITY	
Course Code: 25VAC101/25VAC202	**Continuous Evaluation:**30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To acquaint the students with the fundamental concepts of democracy, diversity and the Constitution.
2. To make students understand the functioning of the three wings of the State
3. To make the students appreciate the purpose of decentralised administration under the Constitution and its functioning
4. To make students analyse and discuss various rights and duties under the Constitution of India

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in alignment with National Education Policy (NEP). After completion of course, students would be able to:

1. Explain the concept of democracy, diversity and the Constitutional Values
2. Describe the functioning of the three wings of the State
3. Sketch the functioning of decentralised administration under the Constitution of India and appreciate the political dimensions.
4. Examine the scope of various rights and duties under the Constitution of India.

<u>COURSE CONTENTS</u>

UNIT	COURSE CONTENTS	HOURS
UNIT-I	DEMOCRACY, DIVERSITY AND THE CONSTITUTION: • Concept of democracy and importance of right to vote • Electoral Politics • Concepts of diversity and discrimination on the grounds of gender, religion and caste • Concept of democratic government • Constitution design and salient features • Preamble to the Constitution of India	8
UNIT-II	THE THREE WINGS OF THE STATE : • The definition of State in Constitution of India • Parliament, the State legislature and the making of laws • Concept of cooperative federalism • The Executive and Administration • Role of Governor and the President of India • The Judiciary	8

UNIT-III	LOCAL GOVERNMENT AND ADMINISTRATION: • Panchayati Raj System • Rural and Urban administration • Social and Economic Justice for the marginalized • Directive Principles of State Policy	7
UNIT-IV	RIGHTS AND DUTIES: • Fundamental Rights (Part III of the Constitution) • Protection of Fundamental Rights – Writ petitions in High Court and Supreme Court of India • Fundamental Duties • The concept of Fraternity and secularism • Public utilities and privatization	7

RECOMMENDED TEXT BOOKS:

1. D.D. Basu, *Introduction to the Constitution of India,* (LexisNexis, 26th Ed., 2022).
2. M. Laxmikant, *Indian Polity*(McGraw Hill, 7th Ed., 2023)
3. Subhash C. Kashyap, *Constitution of India* (Vitasta Publishing Pvt. Ltd, 1st Ed., 2019)

REFERENCE BOOKS:

1. M.P. Jain*, Indian Constitutional* Law (Lexis Nexis, 8th Ed., 2018).
2. H.M. Seervai, *Constitutional Law of India* (Law & Justice 4th Ed., 2023)
3. P.M. Bakshi, *The Constitution of India*, (Universal Law Publishing Co.,18th Ed., 2022)
4. J.N.Pandey*, Constitutional Law of India*(Central Law Agency, 59th Ed.,2022, Allahabad

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course name	Course Objectives	CLO 1	CLO 2	CLO 3	CLO 4
I/II	25VAC101/25VAC202	INDIAN CONSTITUTION & POLITY	CO1	x	x	x	
			CO2		x		x
			CO3			x	x
			CO4				x

SEMESTER II

ENGINEERING MATHEMATICS-II (COMMON TO ALL BRANCHES EXCEPT BIO MEDICAL ENGINEERING)	
Course Code:25AS202	**Continuous Evaluation:** 30 Marks
Credits: 4	**End Semester Examination:** 70Marks
L T P : 3 1 0	
Prerequisite: Engineering Mathematics-I	

COURSE OBJECTIVES (COs):

1. To enable students to have skills that will help them to solve real-world problems based on different types differential equations.
2. To explain basics of vector spaces and linear transformations.
3. To describe Laplace and inverse Laplace transforms with their properties.
4. To understand Analytic functions, Construction of Analytic Functions
5. To equip the students with concept of Complex Integration, Tayler's and Laurent's Expansions, Residues and Singularities.

COURSE LEARNING OUTCOMES (CLOs):

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Interpret various physical models through higher order differential equation and solve such linear ordinary differential equation.
2. Describe the basics of vector spaces and linear transformations.
3. Apply Laplace transforms to find the solution of initial value problems.
4. Demonstrate the concept of Analytic functions & its constructions.
5. Evaluate Complex Integration, Taylor's and Laurent's Expansion, Singularities and Residues.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	Linear differential equation with constant Coefficient, Complimentary Functions, Particular Integrals, Euler – Cauchy differential equations, Second order linear differential equations – Variation of Parameters & Method of undetermined coefficient. **Application domain problems:** Electric field, rate of growth and decay of population dynamic, Antenna Design	12
UNIT-II	Binary composition, internal and external composition, Vector Spaces- Definition and Examples, Vector subspaces, Linear combination of Vectors, Basis and Dimension of Vector Spaces. Linear transformations, Properties of Linear Transformation, Null space and range of linear Transformation, Matrix representation of linear transformation. **Application domain problems:** Image processing, Creating and manipulating 3D models	12

UNIT-III	Laplace Transforms, Existence theorem, Standard Properties, Laplace transforms of Derivatives and Integrals, Unit Step Function, Laplace Transform of Periodic functions, Inverse Laplace Transforms, Convolution theorem, Applications of Laplace transforms for solving IVP. **Application domain problems:** Signal transformation and control systems	12
UNIT-IV	Function of complex variables: Limit, continuity, Differentiability and Analyticity of functions, Cauchy-Riemann Equations (Cartesian and polar forms), Harmonic functions, Construction of Analytic Function, Determination of Harmonic conjugate, Milne-Thomson's method. **Application domain problems:** Special functions and error functions, Computer graphics for rendering images, modelling surfaces, and creating visual effects.	12
UNIT-V	Line integral, Cauchy's Integral Theorem, Cauchy's Integral Formula, Cauchy's Integral Formula for Derivatives, Cauchy's Inequality, Taylor's, and Laurent's Expansions (statements only), Singularities, Poles and Residues, Cauchy's residue Theorem, Applications - Evaluation of real integrals f (sin θ, cos θ) over (0, 2π). **Application domain problems:** Electrical circuits, Image processing and communication system, Diffraction on a flat screen.	12

TEXT BOOKS/REFERENCE BOOKS

1. Srimanta Pal and Subodh C. Bhunia, Engineering Mathematics, Oxford first edition, 2015.
2. Grewal B.S, Higher Engineering Mathematics, Khanna Publications, 44th Edition, 2017
3. S. H. Friedberg, Arnold J. Insel, E. S.Lawrence, Linear Algebra, 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
4. E. Kreyszig, Advanced Engineering Mathematics, Wiley-India, 10th Edition, 2017
5. Kandasamy P et al. Engineering Mathematics, S. Chand & Co., New Delhi, revised edition.
6. Dass H. K., Advanced engineering Mathematics, Sultan Chand Publication, Delhi, 2013.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4	CLO5
II	25AS202	ENGINEERING MATHEMATICS-II	CO1	✓				
			CO2		✓			
			CO3			✓		
			CO4				✓	
			CO5					✓
								✓

MATHEMATICS-II (FOR BME ONLY)	
Course Code: 25AS204	**Continuous Evaluation:** 30 Marks
Credits: 4	**End Semester Examination:** 70Marks
L T P : 3 1 0	
Prerequisite: Mathematics-I	

COURSE OBJECTIVES (COs):

1. To familiarize with the concept of complex variables.
2. To introduce the concept of successive differentiation and nth derivatives.
3. To introduce the concept of Differentiation of several variables.
4. To familiarize with concepts of vector and vector differentiation.
5. To introduce the concept of differential equations and their applications

COURSE LEARNING OUTCOMES (CLOs):

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Apply the knowledge to construct analytic functions.
2. Execute the higher order differentiation.
3. Develop the essential tool of differentiation of several variables.
4. Illustrate the concept of vector differentiation.
5. Apply the knowledge of differential equations in solving problems

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	Complex numbers and their properties, Complex plane, Polar form of complex numbers, Powers and Roots, Sets of Points in the Complex plane, De-Moivre's theorem and its simple applications. **Application domain problems:** Signal processing of bio-signals	12
UNIT-II	Successivedifferentiation,n^{th}orderderivativesofstandardfunctions,Leibnitz theorem(withoutproof) **Application domain problems:** Population dynamics	12
UNIT-III	Introduction, Limit & Continuity, Partial derivatives, Homogeneous functions and Euler's theorem, Total derivatives, Jacobians, Properties of Jacobians. **Application domain problems:** Analysis of blood flow, stability analysis	12
UNIT-IV	Introduction, Scalar and vector point functions, differentiation formulae, Level surface, Gradient, Divergence, Curl, Directional derivatives, Simple Applications. **Application domain problems:** Analysis of bio fluids in biomechanics	12
UNIT-V	Linear differential equation with constant Coefficient, Complimentary Functions, Particular Integrals, Euler – Cauchy differential equations, Second order linear differential equations – Variation of Parameters & Method of undetermined coefficient. **Application domain problems :**Mathematical modelling in biology	12

TEXTBOOKS/REFERENCE BOOKS

1. Grewal B.S,Higher Engineering Mathematics,KhannaPublications,45thEdition,2020.
2. Jain R. K., Iyengar S. R. K., Advanced Engineering Mathematics, 7^{th} Edition, Narosa Publishing House, 2021.
3. BaliN.P.,Goyal M,Advanced Engineering Mathematics, Laxmi Publications, NewDelhi,2018.
4. Dass H.K.,Advanced Engineering Mathematics, SultanChandPublication,Delhi,2018.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4	CLO5
II	25AS204	**Mathematics-II**	CO1	✓				
			CO2		✓			
			CO3			✓		
			CO4				✓	
			CO5					✓

HINDI -II	
Course Code: 25HIN202	**Continuous Evaluation:** 30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 2 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

हिंदी विषय के प्रश्नपत्र की सामग्री निर्धारण में ज्ञान तथा शिक्षा के बदलते परिप्रेक्ष्य को ध्यान में रखा गया है| इस सत्र में हिंदी लघु कथाओं को सम्मिलित किया गया है |छात्रों की मौखिक अभिव्यक्ति की क्षमता का विकास करने में निहित मूल्यों का महत्वपूर्ण योगदान होताहै , इससे विद्यार्थियों की कल्पनाशक्ति के विकास के साथ-साथ मनोरंजन भी होताहै |संचार कौशल में मुहावरे ,लोकोक्तियां ,पत्रलेखनऔरअपठितगद्यांश की समझ के द्वारा हिंदीकाप्रचार-प्रसार होगा |इस प्रकार साहित्य के ज्ञान की अभिवृद्धि वैश्वीकरण के संदर्भ में प्रासंगिकता और उपयोगिकता सिध्द करती है

COURSE LEARNING OUTCOMES (CLOs)

पाठ्यक्रमपरिणाम

1. Knowledge Outcome

ज्ञान का परिणाम

At the end of the course, the student should be able to

1. पाठ्यक्रम के अंत में छात्र सक्षम होना चाहिए
2. हिंदी लघुकथाओं के मूल उद्देश्य को समझने में विद्यार्थी निपुण हो जाएंगे |लघुकथाओं से क्या शिक्षा मिलती है ?इसका ज्ञान छात्रों को होगा |व्याकरण के अध्ययन से विद्यार्थियों को भाषा बोलने, लिखने और पढ़ने में सहायता प्राप्त होगी

2. Skill Outcome

कौशल का परिणाम

At the end of the course, the student should be able to

(At the end of the course, the student should be able to)

1. -पाठ्यक्रम केअंत में छात्र सक्षम होना चाहिए
2. -हिंदी लघुकथाओं से मनोरंजन भी होगा|
3. -विद्यार्थी लघुकथाओं के मूलकथ्य को समझेंगे|
4. -विचार तत्व के बोध से अवगत होंगे|
5. -हिंदी में पत्र लेखन और अपठित गद्यांश को समझने में सक्षम होंगे|

<u>COURSE CONTENTS</u>

UNIT	COURSE CONTENTS	HOURS
UNIT-I	इस इकाई में हिंदी लघुकथाओं का संक्षिप्त परिचय दिया गया है– 1.हिंदी लघुकथा का सामान्य परिचय| 2,हिंदीलघुकथाकेप्रमुखप्रकार|	8
UNIT-II	इस इकाई में हिंदी की दो लघुकथाएं सम्मिलित की गई हैं-	8

	1. अंगूरकीबेल 2. किसानऔरठग	
UNIT-III	इस इकाई में हिंदी की दो लघुकथाएं सम्मिलित की गई हैं- 1 बुराईकाफल 2. चारविद्वानब्राह्मण	7
UNIT-IV	यह इकाई संचार कौशल से सम्बंधित है,इसमें (i) प्रेसरिपोर्ट, विज्ञापन, अनुवाद (ii)हिंदी पत्र लेखनऔरअपठित गद्यांश को समझना व तर्क संगत उत्तर देना अपेक्षित है|	7

METHODOLOG पद्धति

- कक्षाव्याख्यान

-व्याकरण के माध्यम से हिंदी शब्दों का उच्चारण व लेखन काअभ्यास किया जाएगा|

-समय-समय पर छात्रों को प्रदत्तकार्य दिया जाएगा|

- साप्ताहिकप्रश्नावली|

-दैनिकप्रश्नावली

REFERENCE BOOKS/ TEXT BOOKS

आवश्यक पुस्तकें और सामग्री

1. पाठ्यक्रममेंनिर्धारितलघुकथाओंकासंकलन|
2. -भाषाविज्ञान ,डॉ .भोलानाथतिवारी, किताबमहलइलाहाबाद|
3. -हिंदीव्याकरण ,कामताप्रसादगुरु ,प्रभातप्रकाशन

GERMAN-II	
Course Code: 25FLGR202	**Continuous Evaluation:** 30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 2 0 0	
Prerequisite: GERMAN-I	

COURSE OBJECTIVES (COs)

The objective of this course is to impart basic knowledge of German language to the students. The course intends to grow the ability of verbal and written communication. Overall, the objective is to facilitate comprehension of daily life contexts in German, both oral as well as written.

1. To develop oral and written skills of understanding, expressing and exchanging information in German language.
2. To develop awareness of the nature of language and language learning.
3. To develop the ability to construct sentences and frame questions.
4. To provide German language as a competitive edge in career choices.
5. To know some of the aspects of the culture of the countries where German language is spoken.

COURSE LEARNING OUTCOMES (CLOs)

After completion of the course the students will have the ability to:

1. Read and write short, simple texts.
2. Understand and take part in short, simple conversations using the skills acquired.
3. Know some aspects of the culture of the countries where the German language is spoken.
4. Read a text and/or e-mail during any employment.

COURSE CONTENTS

UNIT	COURSE CONTENTS	HOURS
UNIT-I	- Zeitangabe, Tageszeit, Uhrzeit, der Tagesablauf - Präpositionen mit Akkusativ, Ordinalzahlen - Wegbeschreibung, die Himmelsrichtungen - Die Gebäude, Verkehrsmittel	8
UNIT-II	- Das Haus - Modalverben - Essen und Trinken, Messeinheiten, Einkaufen - Körperteile und Krankheiten - Futur	8
UNIT-III	- Dativ, Artikel und Personalpronomen im Dativ - Präpositionen mit Dativ, die Wechselpräpositionen - Possessiv-Artikel, die Konnektoren - Schreiben Teil 1 - Trennbare Verben	7
UNIT-IV	- Schreiben Teil 2 (E- Mail Schreiben) - Perfekt	7

	- Vergangenheit erzählen, Das Wochenende, Lebenslauf	

TEXT BOOKS

1.Netzwerk Neu A1 (Kursbuch+Arbeitsbuch)by StefanieDengler, et al.Ernst Klett Sprachen., 2019.

OPEN EDUCATIONAL RESOURCES

1.Website for additional materials:https://www.nthuleen.com/teach.html

REFERENCE BOOKS

1. Studio D A1, Hermann Funk, Christina Kuhn, Silke Demme, 2010, Cornlesen.
2. Einfach Grammatik: Übungsgrammatik Deutsch A1 bis B1, Paul Rusch, Helen Schmitz, 2012, Langenscheidt.
3. Berliner Platz - neu: Lehr- und Arbeitsbuch, Christiane Lemcke, Lutz Rohrmann, Theo Scherling, 2009, Klett Sprachen.
4. Tangram aktuell 1: A1, Rosa-MariaDallapiaza, Eduard von Jan, Sabine Dinsel, 1998, Hueber Verlag.
5. Lernziel Deutsch: Deutsch als Fremdsprache, Teil 1, Wolfgang Hieber, 1984, Max Hueber Verlag.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4
II	25FLGR202	**GERMAN-II**	CO1	√	√		
			CO2	√			
			CO3		√		
			CO4				√
			CO5			√	

FRENCH-II	
Course Code: 25FLFR202	**Continuous Evaluation:** 30 Marks
Credits: 2	**End Semester Examination:** 70 Marks
L T P : 2 0 0	
Prerequisite: French-I	

COURSE OBJECTIVES (COs)

1. To develop the skills to construct short and simple sentences.
2. To prepare the students to identify themselves with the culture of the Francophone world.
3. To develop in students a good degree of understanding of syntactic, lexical, grammatical and stylistic features of the French language.
4. To demonstrate differences and diversity of the French speaking world with their own

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of the course, students would be able to:

1. Express themselves in French used in daily conversations.
2. Recognise and explain cultural artefacts, practices and perspectives of the French speaking world.
3. Apply linguistic knowledge to analyse a simple text, identifying its salient features, and thus express themselves effectively in French.
4. Contrast culture of the French speaking world with their own, andhence demonstrate an increased awareness towards its key practices and perspectives.

COURSE CONTENTS

UNIT	Unités	Objectifs de Communication	Grammaire	Lexique	Heures
UNIT-I	Journée Typique	Parler d'habitudes, Exprimer l'Heure, S'Informer sur l'Heure, Moment et Fréquence.	Verbes Pronominaux au Présent. Verbes Aller et Sortir	Heure, Moments de la Journée. Activités Quotidiennes. Adverb. Météo.	8
UNIT-II	Achats	S'informer sur un Produit. Acheter et Vendre un Produit. Donner Son Avis. Parler du temps.	Adjectifs Interrogatifs. Adjectifs Démonstratifs(Ce, cette, ces). Genre et Nombre. Verbe Prendre.	Vêtements. Couleurs. Fruits et Légumes.	8

UNIT-III	**Alimen tation**	Parler des Plats et des Aliments. Commander un Menu dans un Restaurant. Situer une Action dans le Futur	Future Proche: Aller +Infinitif. Articles Partitifs(du/de la/des/d'). Pronoms COD. Future.	Aliments. Vocabulaire des Quantités.	7
UNIT-IV	**expérie nce vécue**	Parler du passé. Parler d'expériences. Parler de ce que nous savons faire.	Passé Composé. Imparfait	Verbes Savoir, Pouvoir et Connaître. Adjectifs Qualificatifs. Vocabulaire des Savoirs et Compétences. Récit de Vie.	7

TEXT BOOKS

1. Version Originale 1, Livre de l'élève: Denyer M. & Agustin GarmendiaA. & Olivieri M L L., éd. Maisons des Langues, Paris. 2013.

REFERENCE BOOKS

1. Alter Ego 1, Livre d'élève, Berthet A. & Hugo C. & Kizirian M. V. &Sampsonis B. & Waendendries M., éd Hachette, Paris, 2006.
2. Connexions 1, Loiseau Y. & Mérieux R., éd. Didier, Paris, 2004.
3. Le Nouveau Sans Frontiers, Vol. 1, P. Dominique, J. Girardet et al,CLE International, Paris, 2013.
4. Le Robert & Nathan Conjugation, Paperback, Le Robert Nathan.

Mapping Matrix of Course Objectives (COs) and Course Learning Outcomes (CLOs)

SEM	SUB CODE	Course Name	Course Objectives	CLO1	CLO2	CLO3	CLO4
II	25FLFR202	**FRENCH-II**	CO1	√		√	
			CO2		√		√
			CO3			√	
			CO4				√

SEMESTER - III

SPORTS, YOGA & FITNESS	
Course Code: 23VAC301	Continuous Evaluation: Marks
Credits: 2	End Semester Examination: Marks
L T P: 1 0 2	
Prerequisite: Nil	

Yoga Practices & Physical Education

1. Teaching of different asanas – demonstration practice and correction.
2. Teaching of weight training – demonstration practice and correction.
3. Teaching of circuit training – demonstration practice and correction.
4. Teaching of calisthenics – demonstration practice and correction.
5. Teaching of skills of Football – demonstration, practice of the skills, correction, involvement in game situation (For girls teaching of Tennikoit)
6. Teaching of different skills of Football – demonstration, practice of the skills, correction,involvement in game situation (For girls teaching of Tennikoit)
7. Teaching of advance skills of Football – involvement of all the skills in game situationwith teaching of rules of the game
8. Teaching of skills of Basketball – demonstration, practice of the skills, correction ofskills, involvement in game situation
9. Teaching of skills of Basketball – demonstration, practice of the skills, involvement ingame situation
10. Teaching of skills of Basketball – involvement of all the skills in game situation withteaching of rule of the game
11. Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills,involvement in game situation
12. Teaching of skills of Kabaddi – demonstration, practice of the skills, correction of skills,involvement in game situation
13. Teaching of advance skills of Kabaddi – involvement of all the skills in game situationwith teaching of rule of the game
14. Teaching of skills of Ball Badminton – demonstration, practice of the skills, correctionof skills, involvement in game situation
15. Teaching of skills of Ball Badminton – involvement of all the skills in game situationwith teaching of rule of the game
16. Teaching of some of Asanas – demonstration, practice, correction and practice
17. Teaching of some more of Asanas – demonstration, practice, correction and practice
18. Teaching of skills of Table Tennis – demonstration, practice of skills, correction andpractice and involvement in game situation
19. Teaching of skills of Table Tennis – demonstration, practice of skills, correction andpractice and involvement in game situation

20. Teaching of skills of Table Tennis – involvement of all the skills in game situation withteaching of rule of the game
21. Teaching – Meaning, Scope and importance of Physical Education
22. Teaching – Definition, Type of Tournaments
23. Teaching – Physical Fitness and Health Education
24. Construction and laying out of the track and field (*The girls will have Tennikoit andThrow Ball).

Youth and yoga

History, philosophy, concept, myths and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Notes:

1) Compulsory Uniform: Half pants, Tee Shirts, Shoes and socks all white (Girls will have white Tee Shirt and Track pants)

2) The games mentioned in the practical may be interchanged depending on the season and facilities.

ENGINEERING MATHEMATICS-III (COMMON TO ALL BRANCHES)	
Course Code:23AS301	Continuous Evaluation: …. Marks
Credits: 4	End Semester Examination:… Marks
L T P : 3 1 0	
Prerequisite: Nil	

COURSE EDUCTIONALOBJECTIVES (CEO)

- To familiarize the students with partial differential equations and their solution, Boundary value problem, Fourier transforms, z- transforms and basic concepts of Linear algebra.
- To solve boundary value problems, Heat and Wave equations.
- To gain good knowledge in the application of Fourier transform.
- To demonstrate understanding Z-transform and analyzing Discrete signals by using Z-transform.
- To understand Vector spaces, and Linear Transformation with it's properties.

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

- Solve different types of partial differential equations.
- Find solutions of boundary value problems including heat and wave equations.
- Apply and analyze Fourier transforms with different applications.
- Evaluate the problems using z-transforms.
- Understand linear algebra and its application to Engineering.

MAPPING COURSE EDUCTIONALOBJECTIVES & COURSE LEARNING OUTCOMES

CLO / CEO	01	02	03	04
01	✓			
02	✓			
03		✓		
04			✓	
05				✓

COURSE CONTENTS

Unit-I: Partial differential equation – I

Formation of partial differential equation by eliminating arbitrary constants and arbitrary functions. Formation of partial differential equation by eliminating arbitrary functions of the form $\phi(u, v) = 0$. Solution of standard types of first order equations. Solution of standard types of first order equations. Lagrange's linear equation of first order. Linear Homogeneous partial differential equations of second and higher order with constant coefficients. Formation - Solution of standard types of first order equations - Lagrange's equation - Linear homogeneous partial differential and second and higher order with constant coefficients.

Unit-II: Partial differential equation – II

Classification of partial differential equations. Method of separation of variables. One dimensional Wave Equation and its possible solutions. Initial and Boundary value Problems with zero velocity – related problems and Non-zero velocity- related problems. One dimensional heat equation and its possible solutions. Steady state conditions and zero boundary conditions related problems. Introduction to two dimensional heat equation and its possible solutions in steady state. Two dimensional heat equation - Steady state heat flow equation

Unit- III: Fourier Transforms

Fourier Transforms- Elementary properties of Fourier transforms. Fourier Transforms and related problems- Fast Fourier Transform. Fourier Sine Transforms and their properties-problems. Fourier Cosine Transforms and their properties-problems. Convolution Theorem (without proof)-applications. Parseval's Identity (without proof)-applications.

Unit-IV: Z – Transforms

Z Transforms: Definition and properties of Z- Transforms, Inverse Z- Transforms, and Application of Z-Transforms to difference equations.

Unit-V: Vector Spaces

Vectors in two dimensional space and n-dimensional space, Vectors addition and scalar multiplication of Vectors, Vector Spaces: Definition and Examples General properties of vector spaces, Linear combination of Vectors, Linear independence and Linear dependence of Vectors. Linear transformations, linear operators, Properties of Linear Transformation, Algebra of Linear transformation, Matrix Representation of linear transformation, Linear map Associated with Linear Transformation.

TEXT BOOKS

1. E. Kreyszig, Advanced Engineering Mathematics, Wiley-India, 10th Edition, 2017.
2. Grewal B.S., Higher Engineering Mathematics, 44th edition, Khanna Publishers, 2019
3. Gilbert Strang, Introduction to Linear Algebra, Fifth Edition (2016)

REFERENCE BOOKS

1. R.V. Churchill and J. Brown.: "Fourier Series and Boundary Value Problems" McGraw-Hill Book Company 8th edition-2017.
2. M.D. Raisinghania: "Advanced Differential Equations"S. Chand Publishing2018
3. LoknathDebnath, Integral Transforms and their applications, Chapman and Hall/CRC; 2 edition, 2014

STRENGTH OF MATERIALS	
Course Code: 23ME301	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Engineering Mechanics	

COURSE OBJECTIVES (CO)

- To familiarize students with basic concepts of concepts of stress and strain
- To familiarize students with the analysis the beam of different cross sections for shear force, bending moment, slope and deflection
- To impart students with the knowledge of torsion in shafts and springs and its design
- To make students aware of different gear manufacturing operation and the finishing operations
- To acquaint students with an understanding of buckling of columns and struts

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

- Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems for simple three dimensional elastic solids.
- Calculate and represent the stress diagrams in bars and simple structures.
- Understand and solve problems related to to pure and non-uniform bending of beams and other simple structures
- Grasp the concept of design of thick and thin cylinder
- Understand the concept of buckling and be able to solve the problems related to isolated bars

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				
CO 2		√			
CO 3			√		
CO 4				√	
CO 5					√

COURSE CONTENTS

Unit-I CONCEPT OF STRESSES AND STRAINS

Concept of stress and strain, Hooke's law – Tension, Compression, and Shear, stress -strain diagram – Poisson's ratio, elastic constants and their relationship – Deformation of simple and compound bars – Thermal stresses. Principal plane, principal stress, maximum shearing stress – Uniaxial, biaxial state of stress – Mohr's circle for plane stresses.

Unit-II ANALYSIS OF BEAMS

Beams: Types and Transverse loadings–shear force and bending moment diagrams for cantilevers, simply supported and over hanging beams. Theory of pure bending: Bending stresses in simple and composite beams. Shear stress distribution in beams of different sections.

Unit-III TORSION OF SHAFTS AND SPRINGS

Theory of pure torsion, torsion of circular shafts, strain energy due to torsion, simple problems – Type of springs, stiffness, springs in series, springs in parallel, stresses and deflections in helical springs and leaf springs – Design of helical springs and leaf springs.

Unit-IV DEFLECTION OF BEAMS

Slope and deflection of cantilever, simply supported, fixed beam by double integration method – Macauley's method – Moment area method – Strain energy method – Castigliano's theorem

Unit-V COLUMN AND STRUTS

Member subjected to combined bending and axial loads, Euler's theory, Crippling load, Rankine's theory. Cylinders And Shells - Thin cylinder, thin spherical shells under internal pressure–Thick cylinders– Lame's equation

Text Books

1. Bansal,R.K., A Text Book of Strength of Materials, Lakshmi Publications Pvt. Limited, New Delhi, 1996.
2. Prabhu,T.J., Design of machine elements, Private Publication, 1999.
3. Ferdinand P.Beer, and Rusell Johnston, E., Mechanics of Materials, SI Metric Edition, McGraw Hill, 1992.

Reference Books

1. William A. Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series, McGraw Hill International Edition, 3rd Edition, 1994.
2. Srinath, L. S., Advanced Mechanics of Solids, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1987.
3. James M. Gere, Mechanics of Materials Fifth Edition, Brooks/Cole, USA, 2001.
4. Shigley, J. E., Applied Mechanics of Materials, International Student Edition, McGraw Hill Koyakusha Limited, 2000.

MANUFACTURING TECHNOLOGY	
Course Code: 23ME302	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To familiarize students with basic concepts of casting and the various types of casting and its design
- To familiarize students with the working principle and application of metal forming operations
- To impart students with the knowledge of machining operation, types of machining operations and its selection
- To make students aware of different gear manufacturing operation and the finishing operations
- To acquaint students with basic machine tools used in mechanical engineering.

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

- Understand various ways of working of metals
- Understand the concepts of Casting and Welding Technology
- Understand the working of Machining with lathes and automats
- Grasp the concept of Milling machine and Gear manufacturing process
- Understand the various Machine tools used in manufacturing

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				
CO 2		√			
CO 3			√		
CO 4				√	
CO 5					√

COURSE CONTENTS

Unit-I CASTING AND WELDING

Introduction to casting, Patterns, Types, Pattern materials, Allowances – Moulding – types– Moulding sand, Gating and Risering, Cores &Core making. Special Casting Process - Shell, Investment, Die casting, Centrifugal Casting. Special welding– Laser, Electron Beam, Ultrasonic, Electro slag, Friction welding, Electrical resistance welding

Unit-II MECHANICAL WORKING OF METALS

Hot and Cold Working: Rolling, Forging, Wire Drawing, Extrusion – types – Forward, backward and tube extrusion. Sheet Metal Operations: Blanking– blank size calculation, draw ratio, drawing force, Piercing, Punching, Trimming, Stretch forming, Shearing, Bending– simple problems– Bending force calculation, Tube forming – Embossing and coining, Types of dies: Progressive, compound and combination dies

Unit-III THEORY OF METAL CUTTING

Orthogonal and oblique cutting– Classification of cutting tools: single, multipoint – Tool signature for single point cutting tool – Mechanics of orthogonal cutting – Shear angle and its significance – Chip formation– Cutting tool materials– Tool wear and tool life – Machinability – Cutting Fluids– Simple problems.

Unit-IV GEAR MANUFACTURING AND SURFACE FINISHING PROCESS

Gear manufacturing processes: Extrusion, Stamping, and Powder Metallurgy. Gear Machining: Forming. Gear generating process – Gear shaping, Gear hobbing. Grinding process, various types of grinding machine, Grinding Wheel – types – Selection of Cutting speed and work speed, dressing and truing. Fine Finishing – Lapping, Buffing, Honing, and Super finishing.

Unit-V MACHINE TOOLS

Milling Machine – specification, Types, Types of cutters, operations, Indexing methods– simple problems. Shaping, Planning and Slotting Machine – description, Operations, Work and tool holding Devices, Jigs & fixtures. Boring machine – Specification, operations, Jig boring machine. Broaching machine – operations, Specification, Types, Tool nomenclature

Text Books

1. Sharma, P.C., A textbook of Production Technology–Vol I and II, S. Chand & Company Ltd., New Delhi, 1996.
2. Rao, P.N., Manufacturing Technology, Vol I & II, Tata McGraw Hill Publishing Co., New Delhi, 1998.

Reference Books

1. Chapman W. A. J., Workshop Technology Vol. I and II, Arnold Publisher, New Delhi, 1998.
2. Hajra Choudhary, S. K. and Hajra Choudhary, A. K., Elements of Manufacturing Technology, Vol II, Media Publishers, Bombay, 1988.
3. Jain. R. K., Production Technology, Khanna Publishers, New Delhi, 1988.
4. Kalpakjian, Manufacturing Engineering and Technology, Addision Wesley Congmen Pvt. Ltd., Singapore, 2000

ENGINEERING THERMODYNAMICS	
Course Code: 23ME303	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To familiarize students with laws of thermodynamics and its applications
- To familiarize students with the concepts of entropy and availability
- To impart students with the knowledge of thermodynamic relations
- To make students aware of properties of steam and the use of steam tables and Mollier chart.

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

- Understand the basic concepts of thermodynamic system, surrounding, closed and open system, extensive and intensive properties
- Understand the concepts of laws of thermodynamics and its application in everyday life
- Understand the Thermodynamic relations like Maxwell's equations – Clapeyron equation and Dalton's law of partial pressure
- Grasp the concept of entropy, enthalpy, availability, irreversibility
- Understand the application of Mollier diagram, throttling and concpt of isothermal expansion

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				
CO 2		√			
CO 3			√		
CO 4				√	
CO 5					√

COURSE CONTENTS

Unit-I BASIC CONCEPTS OF THERMODYNAMICS Macroscopic Vs Microscopic aspects – Thermodynamic system and surrounding – Forms of energy– Properties of a system – State and equilibrium . Pure substance, Two property rule- Quasi static process– Zeroth law of Thermodynamics - Heat – Work – First law of Thermodynamics – Limitations – Application of

First law to non– flow system– Thermodynamic analysis of control volume - Steady flow energy equation. Applications.

Unit-II SECOND LAW OF THERMODYNAMICS

Kelvin-Planck statement – Clausius statement – Carnot cycle – Cyclic Heat engine – Heat Reservoirs – Refrigerator and Heat Pump – Equivalence of Kelvin – Planck and Clausius statements – Reversibility and Irreversibility.

Unit-III ENTROPY AND AVAILABILITY

Clausius theorem – Clausius inequality – Entropy principle – Property diagrams involving entropy – Entropy change of Ideal gases – Entropy generation in a closed system – Entropy generation in an open system – Third law of Thermodynamics – Introduction to availability in non-flow and flow Process.

Unit-IV THERMODYNAMIC RELATIONS

Maxwell's equations – Clapeyron equation – General relations for dh,du,ds,Cp and Cv – Joule Thomson co-efficient. Ideal gas, relation among the specific heats, internal energy, enthalpy. Analysis of isochoric, isobaric, isothermal, isentropic, isenthalpic processes, representation of the above processes on P-v, T-s planes. Gas Mixtures – Dalton's law of partial pressures – P-V-T behaviour of gas mixtures – Property calculations.

Unit-V PROPERTIES OF STEAM

Steam formation–Temperature Entropy diagram – Mollier diagram – Specific Properties of Steam – Use of steam tables & Mollier chart– Methods of Heating & Expanding the steam – Constant Volume Heating – Constant Pressure Expansion – Isothermal Expansion – Hyperbolic Expansion – Isentropic Expansion – Polytropic Expansion – Throttling process – Dryness fraction measurement. Rankine Cycle, Modified Rankine Cycle

Text Books

1. Nag, P. K, Engineering Thermodynamics, 6 th Edition, Tata McGraw Hill, New Delhi, 1995.
2. Yunus A. Cengel and Michael Boles, A., Thermodynamics–An Engineering Approach, 2nd Edition, McGraw Hill India, 1994

Reference Books

1. Michael Moran, J., and Howard Shapiro, N., Fundamentals of Engineering Thermodynamics, 4th Edition, John Wiley & Sons, New York, 2000.
2. Rayner Joel, Basic Engineering Thermodynamics, 5th Edition, Addison Wesley, New York, 1996.
3. Holman, J. P., Thermodynamics, 4th Edition Tata McGraw Hill, New Delhi, 1998.
4. Kothandaraman, C. P., and Domkundwar, S., A Course in Thermal Engineering, 5th Edition, Dhanpat Rai & Sons, New Delhi, 1998.

ENGINEERING MECHANICS	
Course Code:25ME304	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE EDUCTIONAL OBJECTIVES (CEO)

- To familiarize students with basic concepts of force and moments in equilibrium.
- To impart students with the knowledge of mechanics for structural analysis.
- To familiarize students with the centroids and MOI.
- To make students aware of rigid body kinetics and kinematics.
- To acquaint students with mechanics of deformable bodies.

COURSE LEARNING OUTCOMES (CLOs)

The syllabus has been prepared in alignment with National Education Policy (NEP). After completion of course, students would be able to:

- Understand the concepts of force and moments in equilibrium.
- Apply principles of mechanics to real engineering problems
- Understand the basics of Centroids and MOI.
- Grasp the elements of rigid body kinematics and kinetics.
- Understand the mechanics of deformable bodies.

MAPPING COURSE EDUCTIONAL OBJECTIVES & COURSE LEARNING OUTCOMES

CLO / CEO	01	02	03	04
01	✓			
02	✓			
03		✓		
04			✓	
05				✓

COURSE CONTENTS

UNIT-I FORCE SYSTEMS: Basic concepts: Definitions, Basic assumptions, Scalar & Vector quantities, Free, Forced and fixed vectors. Force System: Force, Classification & Representation, Force as a Vector, Composition of forces, Parallelogram Law, Resolution, Principle of Transmissibility of forces, Moment of a force, Vector representation, Moment for coplanar force system, Varignon's theorem Couple, Vector representation, Resolution of a force into a force and a couple. Force Systems: Coplanar Concurrent Force system and Coplanar Non-Concurrent force systems, Resultant of coplanar force system., Equilibrium of coplanar force system, Free body diagrams, Determination of reactions, Equilibrium of a body under three forces, Lami's theorem.

UNIT –II: FRICTION: Introduction, Wet and Dry friction, Theory of Dry friction, Angle of friction, Angle of Repose, Cone of friction, Coulomb's laws of friction. Basic structural analysis: Plane Truss, Difference between truss and frame, Perfect and imperfect truss, Assumptions and Analysis of Plane Truss, Method of joints, Method of section, zero force members.

UNIT –III- CENTROID AND MOMENT OF INERTIA: Center of Gravity, Center of Mass and Centroid of curves, areas, volumes, Determination of centroid by integration, Centroid of composite bodies. Definition of Moment of inertia of area, Perpendicular axis theorem and Polar moment of Inertia, Parallel axis theorem, Moment of inertia of simple areas by integration, Moment of Inertia of Composite Areas. Moment of Inertia of masses, Parallel axis theorem for mass moment of inertia, Mass moment of inertia of simple bodies by integration, Mass moment of inertia of composite bodies.

UNIT –IV- KINEMATICS OF RIGID BODY: Introduction, Absolute motion, Plane rectilinear motion of rigid body, Plane curvilinear Motion of rigid body, x-y and n-t components, Rotation of rigid bodies, Relative Motion, Plane Motion of rigid bodies, Instantaneous center of zero velocity

UNIT- V - KINETICS OF RIGID BODY: Introduction, Force, Mass and Acceleration, Newton's law of motion, D'Alembert's Principles and Dynamic Equilibrium, Laws of motion applied to planar translation, rotation and plane motion. Work and Energy, Kinetic energy, Principle of work and energy, Conservative forces, Law of conservation of energy, Linear Impulse and Momentum, Conservation of linear momentum.

TEXT BOOKS

1. Engineering Mechanics : Statics and Dynamics", R. C. Hibbler, Pearson
2. Engineering Mechanics " , Thimoshenko & Young , 4ed, Tata McGraw Hill
3. Engineering Mechanics : Statics and Dynamics", Shames and Rao, Pearson
4. Engineering Mechanics " , Bhavikatti , New Age

STRENGTH OF MATERIALS LABORATORY	
Course Code: 23ME351	
Credits: 1	
L T P : 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- The students will be able to understand procedures for conducting tensile, torsion tests on mild steel specimens.
- To determine the Young's modulus using test on beams and tensile test on rods, tension and compression test on springs, bricks, concrete, and impact tests on steel.
- To Determine the strength of various material

COURSE LEARNING OUTCOMES (CLO)

After completion ofcourse, students would be able to:

- Describe the behaviour of materials upon normal external loads.
- Predict the behaviour of the material under impact conditions.
- Recognize the mechanical behaviour of materials.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES		
	CLO1	CLO2	CLO3
CO1	✓	✓	
CO2		✓	
CO3	✓	✓	✓

LIST OF EXPERIMENTS

Experiment 1: Tensile test on mild steel rod.
Experiment 2: Torsion test on mild steel rod.
Experiment 3: Charpy and Izod impact test on steel specimen.
Experiment 4: Double shear test on steel rod.
Experiment 5: Compression test on brick and concrete blocks.
Experiment 6: Tension and compression test on helical springs.
Experiment 7: Brinell and Rockwell hardness test
Experiment 8: Fatigue Testing on Steel Specimen

TEXT BOOKS

1. Kazimi, S. M. A., *Solid Mechanics*, First Revised Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1994.

REFERENCE BOOKS

2. Laboratory Manual

MANUFACTURING PROCESS LABORATORY	
Course Code: 23ME352	
Credits: 1	
L T P : 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To impart hands-on training to the students on various machines used in the manufacturing industry
- To familiarize students with the working of lathe, its parts and various operations that could be performed on lathe machine
- To impart students with the knowledge of types of milling operation and operations that could be performed on milling machine
- To make students aware of different types of surface finish operations like grinding
- To acquaint students with understanding of shaping machine and quick return mechanism

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

- Understand the working of various types of lathe operations.
- Produce flat surface and contour shapes on the given component.
- Learn various methods of making gears.
- Have the ability to make good quality products with good surface finish.
- Learn to operate machines and metal cutting operations

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				
CO 2		√			
CO 3			√		
CO 4				√	
CO 5					√

LIST OF EXPERIMENTS

Exp. No. 1 Introduction- lathe machine, plain turning, Step turning & grooving (Including lathe mechanisms, simple problems).

Exp. No. 2 Taper turning-compound rest/offset method & Drilling using lathe (Including Drilling feed mechanism, Twist drill nomenclature, and Different types of taper turning operations).
Exp. No. 3 External threading-Single start (Including Thread cutting mechanism-simple problems).
Exp. No. 4 Eccentric turning-Single axis.
Exp. No. 5 Shaping-V-Block (Including Shaper quick return mechanism).
Exp. No. 6 Grinding-Cylindrical /Surface/Tool & cutter.
Exp. No. 7 Slotting-Keyways (Including Broaching tool nomenclature and Slotter mechanism).
Exp. No. 8 Milling-Polygon /Spur gear (Including Milling mechanism, simple problems).
Exp. No. 9 Gear hobbing-Helical gear.
Exp. No. 10 Drilling, reaming, counter boring.
Exp. No. 11 Planning/Capstan lathe/Burnishing process (Planner Mechanism, Description of capstan and turret lathe).
Exp. No. 12 Mini Project work- Application oriented products using above experiments.

Text Book

1. Sharma, P.C., A textbook of Production Technology–Vol I and II, S. Chand & Company Ltd., New Delhi, 1996.
2. Rao, P.N., Manufacturing Technology, Vol I & II, Tata McGraw Hill Publishing Co., New Delhi, 1998.

Reference Books

1. Chapman W. A. J., Workshop Technology Vol. I and II, Arnold Publisher, New Delhi, 1998.
2. Hajra Choudhary, S. K. and Hajra Choudhary, A. K., Elements of Manufacturing Technology, Vol II, Media Publishers, Bombay, 1988.
3. Jain. R. K., Production Technology, Khanna Publishers, New Delhi, 1988.
4. Kalpakjian, Manufacturing Engineering and Technology, Addision Wesley Congmen Pvt. Ltd., Singapore, 2000

INDUSTRIAL AUTOMATION LEVEL-I	
Course Code: 24CS0201B	
Credits: 1	
L T P : 0 0 2	
Prerequisite: None	

COURSE OBJECTIVES (CO)

- To acquaint students with the principles and objectives of Industrial Automation
- To familiarize students with the actuators and sensors
- To acquaint students with the process of PLC programming
- To make students understand the basic concepts of HMI and MPS
- To familiarize students with Industrial Robots

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to demonstrate:

- The understanding of Industrial Automation
- The principles of sensors and their outputs
- The process of PLC programming
- The understanding of concepts of HMI and MPS
- The operation of Industrial Robotics

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					
CO5					

COURSE CONTENTS

Basic Level-1 Experiments

1. Aim: To learn the Basics of Servo Motor
   - Methodology: Understand the basic principles of servo motors, wire and program a servo motor, and observe its controlled movements.
2. Aim: To learn the Pneumatics Fundamentals

- Methodology: Set up simple pneumatic circuits, operate pneumatic valves and actuators, and analyze their behavior under different conditions.

3. Aim: To learn the Basics of Hydraulic Systems
   - Methodology: Assemble a basic hydraulic circuit, operate hydraulic cylinders, and measure the force and displacement produced.
4. Aim: To learn the Sensor Technology Basics
   - Methodology: Connect various sensors (e.g., proximity, temperature) to a microcontroller, program them to read data, and analyze sensor outputs.
5. Aim: To learn the Object Detection Using Sensors
   - Methodology: Implement a simple object detection system using infrared sensors, detect objects, and respond with an LED indicator.

6. Aim: To learn the Basics of PLC Programming

- Methodology: Write and upload a basic PLC program to control a simple process, such as turning on a light when a button is pressed.

6. Aim: To learn the Human-Machine Interfaces (HMI) Basics
   - Methodology: Create a basic HMI screen to display and control a simple process, such as monitoring and controlling the status of a motor.
7. Aim: To learn the Basics of MPS Station
   - Methodology: Set up a basic manufacturing process on the MPS station, operate it, and understand the role of each component.
8. Aim: To learn the Robotics Basics
   - Methodology: Learn the fundamental concepts of robotics, assemble a simple robotic arm, and program it to perform basic tasks.

EFFECTIVE COMMUNICATION SKILLS	
Course Code: 23SS351	
Credits: 1	
L T P : 0 0 2	
Prerequisite: Nil	

Training Objectives (TO):-

1. To define and understand communication & its process.
2. To make students practice on communication skills via LSRW approach via instructing, engaging, assessing and re engaging.
3. To enhance the confidence and motivation of students by honing there communication skills.

Training Learning Outcomes (TLO): -

After the completion of the training, the student will have ability:

1. To communicate effectively and interact with people with confidence.
2. To demonstrate and differentiate between various forms of communication.
3. To apply effective communication skills confidently which a student need to get ahead in job and life.

Mapping Matrix of Training Objectives (TO) & Training Learning Outcomes (TLO)			
TRAINING LEARNING OUTCOMES (TLO) TRAINING OBJECTIVES (TO)	TLO1	TLO2	TLO3
TO1			
TO2			
TO3			

Unit	Course Contents	Student Engagement Activity
Unit-I	**Verbal Communication Skills** • Communication Process & its importance • 7 C's of Communication • Formal & Informal Conversation • Requirements of effective verbal communication	Conversation Cards Activity
Unit-II	**Non Verbal Communication Skills** • Importance of non verbal skills in effective communication • Types of non verbal (body language) skills • Barriers to non verbal communication	Power of Body Language Activity

Unit-III	**Listing Skills** • Role of listening skills in effective communication • Barriers to listening • Overcoming listening barriers • Empathetic listening & avoiding selective listening	Chinese Whisper Activity
Unit-IV	**Reading Skills** • Role of reading skills in effective communication • Types of reading strategies to enhance improve reading skills • Comprehension skills	The What IF Activity
Unit-V	**Writing Skills** • Role of writing skills in effective communication • Types of written communication • Advantages & Disadvantages of written communication	The What IF Activity
Unit- VI	**Visual Communication** • Types of visual communication • Importance of visual communication • Picture narration/description technique	Interpret The Picture Activity

Learning Resources	
Text Book	*Communication Skills* by Sanjay Kumar & Pushp Lata: Oxford University Press, 2018.
Reference Book	***Personality Development & Communication Skills-1*** by C B Gupta: Scholar Tech Press,2019.

Pedagogy

- The training will be based on the concept of learning by practice.
- The training will involve 30% of the training time on briefing and demonstration & the remaining 70% will be focusing on student's engagement in training activities.
- The training will follow a circular approach where students are engaged, evaluated, given feedback and then re engaged.

Internal (Continuous Assessment & Evaluation) & End Term (Assessment & Evaluation) for Effective Communication Skills Course

Unit No.	Unit Name	Internal Assessment Parameter	Internal Marks (70)	End Term Assessment Parameters	End Term Marks (30)
1	Verbal Communication Skills	Speech Activity	15	Written Test	10

2	Non Verbal Communication Skills	Role Play	15		
3	Listening Skills	Oral Assessment	10		
4	Reading Skills		10	Viva	20
5	Written Skills	Written Assignment	10		
6	Visual Communication		10		

SEMESTER - IV

FLUID MECHANICS	
Course Code:23ME401	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

- To understand the properties of fluids, its kinematic and dynamic
- To understand the behavior through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations
- To familiarise with the hydrodynamic forces acting on vanes and their performance evaluation.
- To familiarise with basic concepts of velocity profiles, dimensionless numbers and dimensional analysis.
- To understand the theory of boundary layer, working and performance characteristics of various hydraulic machines like pumps and turbines.

COURSE LEARNING OUTCOMES (CLO)

After completion ofcourse, students would be able to:

- Student will know the concept of fluid and its properties, manometry, hydrostatic forces acting on different surfaces and problem-solving techniques.
- exposed to the basic laws of fluids, flow patterns, viscous flow
- Aware of the basic concepts of velocity profiles, dimensionless numbers and dimensional analysis.
- Student will know the hydrodynamic forces acting on vanes and their performance evaluation.
- Student will be in a position to evaluate the performance characteristics of hydraulic turbines. Also, knowledge on hydraulic systems.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04	CLO 05
CO 01	✓				
CO02		✓			
CO 03			✓		
CO 04				✓	
CO 05					✓

COURSE CONTENTS

UNIT I- Fluid statics:

Dimensions and units: physical properties of fluids- specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric gauge and vacuum pressure –measurement of pressure. Manometers Piezometer, U-tube, inverted and differential manometers. Pascal's law, hydrostatic law. Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies.

UNIT II - Fluid kinematics

Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, Condition for irrotational flow, flow net, source and sink, doublet and vortex flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications

Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes, total energy line-hydraulic gradient line

UNIT-III - Boundary Layer Theory

Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

Dimensional Analysis: Similitude and modelling – Dimensionless numbers

UNIT IV - Basics of turbo machinery

Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

Centrifugal pumps, Reciprocating pumps : classification, working, work done,specific speed of pumps,characteristic curves, cavitation & NPSH.

UNIT V- Hydraulic Turbines

classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design –draft tube-theory functions and efficiency.

TEXT BOOKS

1. Modi & Seth., Hydraulics & Fluid Mechanics, Standard Book House, N.Delhi
2. Dr. R.K. Bansal, "Fluid Mechanics & Hydraulic Machines", Laxmi Publications (P) Ltd.
3. R.K. Rajput. "Fluid Mechanics and Hydraulic Machines" , S.chand Publication
4. Domkundwar & Domkundwar, "Fluid Mechanics and Hydraulic Machines" Dhanpatrai &Co.

REFERENCE BOOKS

1. S.K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, TMH
2. Yunus A. Cengel, "Fluid Mechanics", TMH 2010
3. . F. Douglas, "Fluid Mechanics", Pearson Education, 2011.

DESIGN OF MACHINE ELEMENTS	
Course Code: 23ME403	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To familiarize the various steps involved in the Design Process
2. To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
3. To learn to use standard practices and standard data
4. To learn to use catalogues and standard machine components

(Use of Design Data Book is permitted)

COURSE LEARNING OUTCOMES (CLO)

Upon the completion of this course the students will be able to

1. Explain the influence of steady and variable stresses in machine component design.
2. Apply the concepts of design to shafts, keys and couplings.
3. Apply the concepts of design to temporary and permanent joints.
4. Apply the concepts of design to energy absorbing members, connecting rod and crank shaft.
5. Apply the concepts of design to bearings.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO 1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS

Introduction to the design process – factors influencing machine design, selection of materials based on mechanical properties – Preferred numbers, fits and tolerances – Direct, Bending and torsional stress equations – Impact and shock loading – calculation of principle stresses for various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety – theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT II SHAFTS AND COUPLINGS

Design of solid and hollow shafts based on strength, rigidity and critical speed – Keys, keyways and splines – Rigid and flexible couplings.

UNIT III TEMPORARY AND PERMANENT JOINTS

Threaded fasteners – Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures – theory of bonded joints.

UNIT IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS

Various types of springs, optimization of helical springs – rubber springs – Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT V BEARINGS

Sliding contact and rolling contact bearings – Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, — Selection of Rolling Contact bearings

Text Book

1. V.B. Bhandari., Design of Machine Elements, Tata McGraw Hill, New Delhi.
2. Prabhu, T. J., Design of machine elements, Kasthuri Publication, Chennai, 2003.
3. Patel, R. C., Sikh, S. S. and Pandya, Machine Design, Volume I, C. Jamdan & Co., 1999.

Reference Book and other materials

1. Norton, R. L., Design of Machinery, McGraw Hill, 1999.
2. Robert C. Juvinall, Fundamentals of Machine Component Design, John Wiley & sons, 3rd Edition, 2002.
3. Spots, M. F., Design of Machine Elements, Prentice Hall of India Private Limited, New Delhi, 1983.

COMPUTER AIDED DESIGN AND MANUFACTURING (CAD & CAM)	
Course Code: 23ME404	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

- To introduce the student to the basic tools of computer-aided design (CAD) and computer aided manufacturing (CAM).
- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
- To understand the importance of solid modelling.
- To introduce how computer can be applied in mechanical engineering design.
- To perform part programming for CNC operation

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP).

After completion ofcourse, students would be able to:

- Explain lifecycle of a product and the role of computer-aided design (CAD) in product development.
- Create the different wireframe primitives, surface primitives and solid primitives using parametric representations.
- Apply geometric transformations on the created wireframe, surface and solid models.
- Understand concepts of modeling in 2D and 3D.
- Apply concepts of computer graphics.
- Understand different CAD Packages and its features.
- Apply the CNC machine tools and programming manufacturing processes

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	COL 1	COL 2	COL 3	COL 4	COL 5
CO 1	✓				
CO 2		✓			
CO 3			✓	✓	
CO 4				✓	
CO 5					✓

COURSE CONTENTS

Unit-I: Fundamentals of computer graphics

Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3Dtransformations- homogeneous coordinates - graphic primitives (point, line, circle drawing algorithms)-
Clipping- viewing transformation.

Unit-II: Geometric modeling

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B-Rep), Sweeps Representation, Constructive Solid Geometry (CSG).

Unit- III: Visual realism

Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence Algorithms, Warnock's Algorithm, Priority Algorithms– shading – coloring – computer animation.

Unit-IV: Cad standards

Standards for computer graphics- Graphical Kernel System (GKS) - Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, ACIS and DXF - communication standards.

Unit-V: Computer numerical control machine tools

Numerical control (NC) machine tools – CNC: types, constructional details, special features. - Part programming fundamentals – manual programming – computer assisted part programming – Turning, Drilling and Milling. Introduction to Distributed Numerical control (DNC) Machines. Introduction to computer aided process planning.

TEXT BOOKS

1. Ibrahim Zeid, CAD / CAM–Theory and Practice, Tata Mcgraw-Hill, New Delhi, 2010.
2. Radhakrishnan. P., CAD / CAM / CIM - New age international, 2012.
3. Chairs Mcmahon and Jimmie Browne, CAD/CAM, Addision Wesly, New York, 2000.

REFERENCE BOOKS

1. Chandupatla and Belagundu, Introduction to Finite Element Methods in Engineering, Prentice Hall of India Private Limited, New Delhi, 1997.
2. Newman and Sproull R. F., Principles of interactive computer graphics, Tata Mcgraw-Hill, New Delhi,1997.
3. Mikell P. Groover, CAD/CAM, Prentice Hall of India Private Limited, New Delhi, 1997.

FLUID MECHANICS LABORATORY	
Course Code: 23ME451	
Credits: 1	
L T P : 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- The primary aim is to provide resources to perform experiments and gather experimental knowledge and practical experiences in the field of Fluid Mechanics what they have learned
- To enable the students to acquire knowledge of flow meters.
- Give student insight into working of various fluid machines and be able to compare performance of fluid machines under different working conditions.

COURSE LEARNING OUTCOMES (CLO)

After completion of course:

- Student will be able to compare performance of various machines at different operating points.
- Student will be able to gain the knowledge of various flow meters and the concept of fluid mechanics.
- The students will have creative thinking and a deeper understanding and intuitive feel for Fluid Mechanics, Fluid Dynamics, and Fluid Machinery.
- Student will be able to compare performance of various machines at different operating points.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	CLO1	CLO2	CLO3	CLO 4
CO1	✓	✓		
CO2		✓		
CO3			✓	✓

LIST OF EXPERIMENTS

Experiment 1: Flow measurement using Venturimeter.

Experiment 2: Flow measurement using Pitot tube.

Experiment 3: Flow measurement using Orifice meter.

Experiment 4: Verification of Bernoulli‘s theorem.

Experiment 5: Flow visualization using Reynolds apparatus.

Experiment 6: Determination of major loss in pipe.

Experiment 7: Determination of minor losses in pipe fittings.

Experiment 8: Impact of jet of water on vanes.

Experiment 9: performance test on Centrifugal pump.

Experiment 10: Performance test on Reciprocating pump.

Experiment 11: Determine the meta-centric height of a floating body

Experiment 12: Performance test on Pelton turbine.

Experiment 13: Performance test on Kaplan turbine.

Experiment 14: Performance test on Francis turbine

Any 12 Experiment need to perform in the Semester.

TEXT BOOKS

1. Sarbjit Singh, Experiments in Fluid Mechanics - PHI Pvt. Ltd.- New Delhi

REFERENCE BOOKS

1. Laboratory manual
2. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, “*Introduction to Fluid Mechanics*”, Wiley, 8th Edition, 2013.
3. Frank M.White, “*Fluid Mechanics*”, McGraw-Hill, 7th Edition, New Delhi, 2011

COMPUTER AIDED DESIGN (CAD)	
Course Code: 23ME452	
Credits: 1	
L T P : 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To introduce students to 2D drafting and 3D modelling using industry-standard CAD software.
- To develop the ability to create and interpret engineering drawings.
- To familiarize students with computer-aided design and analysis tools for mechanical and civil components.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, student will be able to:

- Create 2D drawings using CAD tools.
- Develop 3D models of machine/civil components.
- Apply CAD tools for design and simulation.
- Interpret and modify technical drawings.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	CLO1	CLO2	CLO3	CLO 4
CO1	✓		✓	
CO2		✓		
CO3				✓

LIST OF EXPERIMENTS:

1. Introduction to CAD interface, tools, and layers.
2. Basic 2D shapes: Lines, Arcs, Circles, Rectangles.
3. Orthographic projections of simple objects.
4. Dimensioning and annotations.
5. Sectional views and hatching.
6. Isometric drawing in 2D.
7. Sketching, extrude, revolve, sweep, and loft features.
8. Modelling of machine components (e.g., nut, bolt, coupling).
9. Assembly of simple parts (e.g., screw jack, piston-cylinder).
10. Creating exploded views and Bill of Materials (BoM).

11. Basic Finite Element Analysis (FEA) using CAD software.
12. Simulation of load, stress, and thermal analysis.
13. Rendering and animation of mechanical assemblies.

Any 10 Experiment need to perform in the Semester.

TEXT/REFERENCE BOOKS:

1. Engineering Graphics and Design, Khanna Publishers, 2020.
2. Parametric Modeling with SOLIDWORKS 2023, SDC Publications, 2023.
3. Mastering CAD/CAM, McGraw Hill Education, 2010.
4. Machine Drawing with AutoCAD, New Age International Publishers, 2018.
5. CATIA V5-6R2018 for Designers, CADCIM Technologies, 2018.

MANUFACTURING AND ASSEMBLY DRAWING LAB	
Course Code: 23ME453	
Credits: 2	
L T P : 1 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To study and understand the technical drawing standards.
2. To acquire the knowledge of fits and tolerances.
3. To enable the students to make assembly drawing of joints, coupling and bearings.
4. To enable the students to prepare production drawing for simple components.
5. To study the assembly drawing of machine elements.

COURSE LEARNING OUTCOMES (CLO)

After completion of this course, the students will learn:

1. The in-depth knowledge of Indian codes and standards for engineering drawing.
2. Ability to represent Fits and Tolerances in technical drawing.
3. Demonstrate the assembly drawing of joints, coupling and bearings.
4. Competence to prepare production drawing for simple components.
5. Demonstrate the assembly drawing of machine elements.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO 1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-I Fundamentals of Machine Drawing

Standardization, Inter-changeability, Selective Assembly, Limits, Fits, Tolerance, Tolerance of form and position, Grades of tolerance, Standard tolerances Machining symbols, Welding symbols, Surface finish indication, Functional and manufacturing datum, Riveted and butt Joints, Fasteners and keys

Unit-II Fits and Tolerances

Tolerance types and representation on the drawing – Fits types and selection for different applications – Basic hole systems - Basic shaft systems – Allowances. Geometric tolerances – Form and positional. Datum and datum features symbols used to represent geometric tolerances.

Unit-III Assembly Drawing (Manual & Using Application Packages)

Application package Introduction: Drawing, Editing, Dimensioning, Assembly, basic principles of GD&T (geometric dimensioning & tolerance)

Shaft joints: Cotter joint and Knuckle joint. Shaft coupling: Muff, Flanged, Flexible, Universal and Oldham's coupling.

Unit-IV Production Drawing

Preparation of production drawing for simple components, interpretation of production drawings.

Unit-V Assembly Drawing of Machine Elements (Manual & Using Application Packages)

Preparation of assembled views given parts details - Lathe tail stock - Lathe chuck - Connecting rod - Screw jack, Machine vice, Tool head of shaper and Stop valve.

Project: Students will be assigned to take up an assembly and create three dimensional and part drawings by following standard drawing practices using application packages.

TEXT BOOKS

1. Gopalakrishnan, K.R., *Machine Drawing,* Subash Publishers, Bangalore, 2000.
2. Narayana, K.L., Kanniah, P. and Venkata Reddy, K., *Production Drawing*, New Age International, New Delhi, 2002.
3. John, K.C., *Textbook of Machine Drawing*, PHI Learning Pvt. Ltd., Delhi, 2013.

REFERENCE BOOKS

1. Sidheswar Kannaiah, N., Sastry, P.V.V.V., *Machine Drawing,* Tata McGraw Hill, New Delhi, 1997.
2. Bhatt, N. D., *Machine Drawing,* Charotar publishing house, Anand, 1999.
3. Junnarkar, N. D., *Machine Drawing*, First Indian print, Pearson Education (Singapore) Pvt. Ltd., 2005.
4. Bhattacharya, Basudeb, *Machine Drawing*, Oxford University Press, 2013.
5. *P.S.G. Design Data Book,* Coimbatore, 2001.
6. Revised IS codes: 10711, 10712, 10713, 10714, 9609, 1165, 10715, 10716, 10717, 11663, 11668, 10968, 11669, 8043, 8000.

DESIGN THINKING AND AUGMENTED VIRTUAL REALITY	
Course Code: 24CS0202B	Continuous Evaluation: ....Marks
Prerequisite: NIL	End Semester Examination:...... Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVES (TO)
1. To recognize the importance of DT.
2. To explain the phases in the DT process.
3. To familiarize the students with the Augmented Virtual Reality Environment.
4. To establish and cultivate a broad and comprehensive understanding of this rapidly evolving and commercially viable field of Computer Science

TRAINING LEARNING OUTCOMES (TLOS) After the completion of TRAINING the students will be able to:
1. Understand and critically apply the concepts and methods of business processes.
2. Understand and analyzing design thinking history and its various concepts.
3. Understand, analyzing and create models with users collaboration to apply design thinking concepts.
4. Understands the role and importance of graphics in VR, AR and MR.
5. Understand the technical and experiential design foundation required for the implementation of immersive environments in current and future virtual, augmented and mixed reality platforms.

TRAINING LEARNING OUTCOME (TLO)-TRAINING OBJECTIVE (TO) MAPPING

	TLO1	TLO2	TLO3	TLO4	TLO5
TO1	✓				
TO2		✓	✓		
TO3				✓	
TO4					✓

TRAINING CONTENTS

MODULE	TRAINING CONTENT	STUDENTS ENGAGEMENT ACTIVITY
I	INTRODUCTION TO DT Recognize the importance of Design Thinking, Identify the steps in the DT process, Recognize the steps in the empathize phase of DT, Identify the steps required to conduct an immersion activity	Product that you loved and hated activity.
II	DEFINE PHASE OF DT Conduct an immersion activity and fill up the DT question template, Recognize the steps to create personas in the define phase of DT, Recognize the steps to create problem statements in the define phase of DT, Define the problem statements in the define phase of DT.	Interview people and fill the DT Question template
III	IDEATE PAHSE OF DT Recognize the steps in the ideate phase of DT, Apply the steps in the ideate phase of DT, Recognize how doodling can help to express ideas, Recognize the importance storytelling in presenting ideas and protypes, Recognize the importance of the prototype phase in DT.	Ideate a solution for a Given problem.
IV	INTRODUCTION TO VR and AR Historical Overview, Current Trends and Future applications of Immersive Technologies, Best practices in VR, AR and Mixed Reality (MR), Categorization of VR and AR techniques, Input and Output devices used in AR and VR. Case Study : Google Lens, ARCore.	To study various AR and VR based existing applications.
V	HANDS ON ACTIVITY	Designing of Solution to the

	This activity will help the students to identify the importance of an innovative approach : a) Discuss about a product that you like or dislike and identify what they need in a bad product to make it good. b) Design a prototype how AR and VR can be used in Education.	Problem.

LEARNING RESOURCES
1. Hooked by Nir Eyal 2. The Art of Creative Thinking by Rod Judkins 3. Start Up nation by Dan Senor and Saul singer 4. Start with Why by Simon Sinek 5. Kelly S. Hale (Editor), Kay M. Stanney (Editor). 2014. Handbook of Virtual Environments: Design, Implementation, and Applications, Second Edition (Human Factors and Ergonomics) ISBN-13: 978-1466511842 6. Michael Madary and Thomas K. Metzinger. 2016. Real Virtuality: A Code of Ethical Conduct.Recommendations for Good Scientific Practice and the Consumers of VR-Technology. Frontiers in Robotics and AI 3, February: 1–23. http://doi.org/10.3389/frobt.2016.00003 7. Jason Jerald. 2015. The VR Book: Human-Centered Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool Publishers. http://doi.org/10.1145/2792790

TEAMWORK & INTERPERSONAL SKILLS	
Course Code: 23SS452	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

Training Objectives (TO):-

- To make the students learn & demonstrate effective team work, leadership & interpersonal skills.
- To equip the students with capability of handling stress and utilisation of work time effectively.
- To make the student understand the importance and application of Emotional Quotient, Critical Thinking & Problem-Solving Skills.

Training Learning Outcomes (TLO): -

After the completion of the training, the student will have ability:

- To be confident working in a team and leading it as well.
- To categorise the work and achieve expected performance within the time frame & will be able to adapt himself to work under various kinds of stress and re-energise himself to bounce back from such situations.
- To get benefitted from Emotional Quotient in building stronger professional relationships and achieveing career and personal goals.
- To face complex problems and effectively deal with it in the job due to Critical Thinking & Problem-Solving Skills.

Mapping Matrix of Training Objectives (TO) & Training Learning Outcomes (TLO)				
Training Learning Outcomes (TLO) Training Objectives (TO)	TLO1	TLO2	TLO3	TLO4
TO1				
TO2				
TO3				

Unit	Course Contents	Student Engagement

Unit - I	**Team Management** • Team communication & team conflict resolution • Role of a team leader • Team goal setting & understanding team development • Team dynamics & multicultural team activity • Johari Window Model	Collaborative Working Game Activity
Unit-II	**Time Management** • Time management matrix • Pareto Principle (80/20 rule) • Development process of plan of action	What You Did Yesterday Activity
Unit-III	**Leadership** • Difference between leadership & management • Types of leadership style • Core leadership skills	Lead The Blindfolded Activity
Unit-IV	**Stress Management** • Sign of stress & its impact • Types of stress • Techniques of handling stress	Keeping Cool Activity
Unit - V	**Emotional Intelligence** • Emotional intelligence & emotional competence • Components & behavioural skills of emotional intelligence	Guess The Emotion Game Activity
Unit - VI	**Critical Thinking** • Types of thinking & Characteristics • Critical thinking standards • Barriers to critical thinking	Think Pair Share Activity
Unit-VII	**Problem Solving** • Types of problems & its solutions • Problem solving process & tools	Think Pair Share Activity

Learning Resources	
Text Book	*Communication Skills* by Sanjay Kumar & Pushp Lata: Oxford University Press, 2018.
Reference Book	*Personality Development & Communication Skills-1* by C B Gupta: Scholar Tech Press,2019.(ISBN No. – 9382209131)

Pedagogy

- The training will be based on the concept of learning by practice.
- The training will involve 30% of the training time on briefing and demonstration & the remaining 70% will be focussing on student's engagement in training activities.
- The training will follow a circular approach where students are engaged, evaluated,given feedback and then re engaged.

Internal (Continuous Assessment & Evaluation) & End Term (Assessment & Evaluation) for Teamwork & Interpersonal Skills

Unit No.	Unit Name	Internal Assessment Parameter	Internal Marks (70)	End Term Assessment Parameters	End Term Marks (30)
1	Team Management	Role Play / Group Activity	10	Written Test	10
2	Time Management		10		
3	Leadership		10		
4	Stress Management	Assignment	10	Viva	20
5	Emotional Intelligence	Written Test	10		
6	Critical Thinking		10		
7	Problem Solving	Case Story Telling	10		

LIVE PROJECTS – I / INTERNSHIP	
Course Code: 23LP451	
Credits: 1	
L T P : 0 0 1	
Prerequisite: Nil	

INDUSTRIAL INTERNSHIP OBJECTIVES (IIOs):

1. To carry out the project assigned to the students.
2. To learn the specific skills and production processes.
3. To learn the importance of team work, safety and work culture.

INDUSTRIAL INTERNSHIP LEARNING OUTCOMES (IILOs):

The student should be able to:

1. Demonstrate the project assigned and its real-life applications
2. Demonstrate the specific skills learned and in-depth understanding of production processes.
3. Demonstrate team work, designing, planning, and organizing of project implementation and work culture of Industry.
4. Demonstrate cleanliness and safety.

MAPPING MATRIX OF THE IIOs AND IILOs:

INDUSTRIAL INTERNSHIP OBJECTIVES	INDUSTRIAL INTERNSHIP LEARNING OUTCOMES			
	IILO 1	IILO 2	IILO 3	IILO 4
IIO 1	✓			
IIO 2		✓		
IIO 3			✓	✓

SEMESTER – V

THEORY OF MACHINES- I	
Course Code: 23ME501	
Credits: 3	
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

The students will be able to

1. To Know the basics of mechanism and perform kinematic analysis.
2. To Calculate the velocity and acceleration for 4-bar and slider crank mechanism
3. To Deduce the number of teeth in gears and torque transmitted in epicyclic gear trains. Apply gyroscopic couple in different transportation vehicles.
4. To know about belt and friction.

COURSE LEARNING OUTCOMES (CLO)

1. The student is expected to be familiar with broader areas of basic mechanisms,
2. An understanding of, velocity and acceleration of simple mechanisms.
   The student would be able to learn the fundamental concepts on Gear & gear train calculations.
3. An understanding of belt and friction.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	⍰			
CO 02	⍰			
CO 03			⍰	
CO 04				⍰

COURSE CONTENTS

Unit-I : Introduction and definitions: Link, element, kinematic pairs – their classification and degrees of freedom, kinematic chain, mechanism, inversion and machine. Kinematic chains and inversions: Four bar chain, single slider crank chain, double slider crank chain and their inversions; mobility of a mechanism – Grashof's law for movability of a Four bar mechanism.

Unit-II : Other mechanisms: Drag link mechanism, Quick return motion mechanisms, Pantograph, Hooke's joint, Ackermann and Davis steering gear mechanisms, Intermittent motion mechanisms, Geneva mechanisms, Toggle mechanisms.
Velocity and acceleration analysis: Determination of velocity and acceleration in mechanisms by relative velocity and relative acceleration methods; relative velocity and relative acceleration of particles on a common link and coincident particles on separate links – Coriolis component of acceleration. Instantaneous centre of rotation: Definitions, Aronhold – Kennedy's theorem of three centres and its application to locate instantaneous centres; Determination of velocity by instantaneous centre method.

Unit-III : Toothed gearing: Classification of gears, nomenclature for straight spur gears, fundamental law of gearing, conjugate teeth, involute and cycloidal tooth profiles, path of contact and arc of contact, interference in involute gears, methods of avoiding interference – undercutting.

Unit-IV : Gear trains: Simple gear trains, compound gear trains for large speed reductions – gear box of an automobile; epicyclic gear trains, alternate methods of determining velocity ratio of epicyclic gear trains, tooth loads and torque calculations in epicyclic gear trains. Differential mechanism of an automobile.

Unit-V :Belt and Rope drive: Flat and V belts and ropes, limiting ratio of tensions, effective tension and power transmitted, centrifugal tension in a belt or rope, effect of centrifugal tension on power transmitted, initial tension, idler and jockey pulleys.

Friction: pivot and collar friction, thrust bearings, single and multi-plate clutches, cone clutches, centrifugal clutches, friction materials.

Text Book

Rattan, S.S., *Theory of Machines*, Tata McGraw Hill Publishing company Ltd., 2 nd Edition ,2005

1. Thomas Bevan, *Theory of Machines*, CBS Publishers and Distributors, 3rd Edition, 1984.

Reference Book

1. *Kinematics and dynamics of machinery:* Wilson and Sadler, Third edition, Pearson.
2. *Theory of Mechanisms and Machines:* Amitabh Ghosh and Ashok Kumar Mallik, Third Edition Affiliated East-West Press.
3. *Theory of Machines and Mechanisms*: Joseph Edward Shigley and John Joseph Uicker, Jr. Oxford University Press *Kinematics and dynamics of machinery:* R L Norton, McGraw Hill.

IC ENGINES	
Course Code: 23ME502	
Credits : 3	
L T P : 3 0 0	
Prerequisite : NIL	

COURSE OBJECTIVES (COs)

On completion of this course, the students are expected

1. To make the students to understand the basic components of internal combustion engine components.
2. To make the students familiar with the different loading devices and performance tests.
3. To gain knowledge in the principles of SI and CI engine combustion.
4. To understand the basic concepts of gas turbine combustion and the latest technological advances in low temperature combustion.
5. To make the students to conduct performance, emission (pollution) and combustion parameters of an engine.

COURSE LEARNING OUTCOMES (CLOs)

On successful completion of the course, the student will be able to,

1. Engine components, auxiliary systems and combustion aspects of SI and CI Engines
2. The latest developments in the field of IC engines like lean burn engines, MPFI, Catalytic converters.
3. Given an engine design specification, predict performance and fuel economy trends.
4. Able to design SI & CI engine system.
5. Develop an ability to optimize future engine design for better fuel economy, performance and emissions.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5	✓		✓		✓

COURSE CONTENTS

Unit-I: BASIC STUDY

Internal Combustion Engine types and classification - SI and CI engines-components, function, operation and comparison - Two-stroke and Four-stroke engines – Description, comparison. Inlet and exhaust manifolds - Basic concepts of supercharging and scavenging - Power output of different types of engines – Efficiency – Specific fuel consumption – IMEP determination –

Simple calculations – Performance characteristics – Heat balance calculations- application of IC engines.

Unit-II: ENGINE AUXILIARY SYSTEMS

Desirable air- fuel ratio for starting, warm-up, acceleration, idling and normal operation. Carburetors – Necessity and function, types. Gasoline injection system – MPFI.

Fuel injection system for diesel engines – Necessity and function, types, injection pump – Nozzle type. Basic study Lubrication system – Need, types, oil properties. Basic study of cooling system – Need, types, air and liquid cooling – Coolant and antifreeze solutions .Ignition system – Conventional and electronic types.

Unit-III: COMBUSTION IN SI ENGINES

Initiation of combustion– Flame velocities – Normal and abnormal combustion - Knocking in combustion – Pre-ignition – Knock and engine variables – Knock reduction – Features and design consideration of combustion chamber– Stratified charge and lean burn engines. Testing of SI Engines.

Unit-IV: COMBUSTION IN CI ENGINES

Various stages of combustion – Vaporization of fuel drops and spray formation – Air motion – Swirl – Squish– Delay period - Diesel knock – Factors influencing diesel knock – Features and design considerations of combustion. Testing of CI engines.

Unit-V: ENGINE POLLUTION

Atmospheric pollution from reciprocating engines – Formation of oxides of nitrogen, carbon monoxide, hydrocarbons, aldehydes, smoke, and particulates. Emission control techniques.

Exhaust gas analysis – Non dispersive infrared gas analyzer, gas chromatography, chemilumines centanalyser

– Flame ionisation detector. Emission standards – National and international limits.

TEXT BOOKS

1. Ramalingam, K. K., *Internal Combustion Engines- Theory and practice*, Scitech publications India Pvt. Ltd., Chennai, 2000.
2. Ganesan, V., *Internal Combustion Engines*, Tata McGraw-Hill, New Delhi, 1994.

REFERENCE BOOKS

1. Heywood, J.B., *Internal Combustion Engine Fundamentals*, McGraw Hill International, New York, 1988.
2. Obert, E. F., *Internal Combustion Engines and Air Pollution*, Harper International Ltd., 1973.
3. Stone, R., *Introduction to Internal Combustion Engines*, Macmillan Press, 1999.
4. Mathur, M. L., and Sharma, R. P., *A course in Internal Combustion Engines*, DhanpatRai& Sons, New Delhi, 1993.

HEAT AND MASS TRANSFER	
Course Code: 23ME503	
Credits: 3	
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

The students will be able.

1. To understand the Conduction mode of heat transfer.
2. To understand the Convection mode of heat transfer.
3. To understand the Radiation mode of heat transfer.
4. Applications of heat transfer in Heat exchangers, insulations etc.
5. To Understand phenomena of Mass Transfer.

COURSE LEARNING OUTCOMES (CLO)

1. Identify and compute the rate of thermal energy transfer, via conduction, convection and radiation, between systems or a system and its surroundings.
2. Select and apply appropriate analytical/numerical solution techniques and/or correlations to heat transfer problems.
3. Analyze and quantify the heat transfer processes in applications typically found in engineering practice, primarily Piping systems, heat exchangers and heating systems
4. Perform the kinds of calculations, which lead to a rational design, and/or an improved understanding of the performance of thermal exchange systems.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	?	?		
CO 02	?	?		
CO 03	?	?		
CO 04			?	?
CO 05				?

COURSE CONTENTS

Unit-I: INTRODUCTION AND CONDUCTION

Various Modes of Heat Transfer, Thermal Diffusivity, Thermal Conductivity of Solids , Liquids and gases and factors affecting conductivity, Fourier‘s Law of Conduction – General equation in Cartesian, cylindrical and spherical co-ordinates - ,One dimensional steady state conduction in plane wall, composite wall, composite cylinder, composite sphere with convection boundaries, Newtons law, overall heat transfer coefficient - Conduction with heat generation - Thermal contact resistance - Overall heat transfer coefficients - Critical thickness of insulation. Effect of variable thermal conductivity.

Unit-II CONDUCTION II

Fins or Extended surfaces: Pin fins, annular fins, longitudinal fins, fin performance and fin efficiency, - Unsteady state conduction - Lumped heat capacity system - Biot number, Fourier number - Semi-infinite, infinite solids – Multi - Dimensional systems, Conduction shape factor - Numerical solutions of two dimensional steady and unsteady state conduction.

Unit-III CONVECTION

Hydrodynamic and thermal boundary layer: Principles and governing equations - Dimensional analysis of free and forced convection heat transfer.

Forced convection: External flow over a flat plate, cylinder, sphere and non-circular ducts, Internal flow through pipe, annular spaces and non-circular conduits. **Natural convection**: vertical, horizontal, inclined surfaces. **Heat exchangers**: Types, fouling factor, log mean temperature difference and number of transfer units' method – Simple problems on double pipe heat exchanger. Introduction to Compact and Plate Heat Exchangers.

Unit-IV RADIATION

Electromagnetic spectrum - Black body emission, emissive power, laws of radiation - Nature, black, grey bodies, concepts, intensity of radiation, radiation shape factor - Thermal resistance and electrical analogy - Radiation heat transfer between two surfaces - Reradiating surface - Radiation shield - Solar radiation - Radiation properties of gases and vapors.

Unit-V HEAT TRANSFER WITH PHASE CHANGE AND MASS TRANSFER

Fick's law of diffusion, Equimolar counter diffusion, Stefan's law, Evaporation in atmosphere-problem, Non-dimensional numbers in mass transfer - Mass transfer coefficients

TEXT BOOK

1. Sachdeva, R.C., *Fundamentals of Heat and Mass Transfer*, 2nd Edition, New Age International (P) Ltd., New Delhi,1998.
2. Kothadaraman, C. P., *Fundamentals of Heat and Mass Transfer*, 4th Edition, New Age International (P) Ltd., New Delhi, 1998.

REFERENCE BOOKS

1. Franker, P. and David, P., *Introduction to Heat Transfer,* 4th edition, John Wiley, New York, 2002.
2. Holman, J. P., *Heat Transfer*, 4th Edition, McGraw Hill book Company, New York, 1989.
3. Nag, P.K., *Heat Transfer and Mass Transfer*, Tata McGraw Hill, 2nd Edition, New Delhi, 2006.
4. Ozisik. M., *Heat Transfer*, McGraw Hill book Company, New York,1998.

COMPUTER AIDED MAUFACTURING (CNC) LAB	
Course Code: 23ME551	
Credits: 1	
L T P: 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To provide hands-on training to the students on various design software in mechanical engineering.
- Create 2D and 3D models of components.
- Create assembly drawing of components.
- Preparing standard drawing layout for modeled parts or assemblies with BoM.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to:

- Drafting practice using computer.
- Modeling of 2D and 3D parts.
- Creating assembly drawing of components.
- Prepare standard drawing layout for modeled parts or assemblies with BoM.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	COL 1	COL 2	COL 3	COL 4
CO 1	✓			
CO 2		✓		
CO 3			✓	
CO 4				?

The students are expected to undergo any computer design software (CATIA, PRO-E, ANSYS, SIMULATION software) courses by all the departments of engineering and technology. Resources for conducting the courses will be found from in-house talents and outside professionals with expertise in the particular course.

IC ENGINES LAB	
Course Code: 23ME552	
Credits: 1	
L T P: 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To provide hands-on experience with internal combustion engines.
- To study engine performance parameters such as brake power, indicated power, efficiency, and fuel consumption.
- To analyze emission characteristics and understand engine testing techniques.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to:

- Understand engine testing methods and performance evaluation.
- Analyze engine emission characteristics.
- Perform experiments and interpret the data for real-world applications.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	□		
CO 02			□
CO 03		□	

1. **Performance Test on 4-Stroke Diesel Engine (Single Cylinder or Multi-Cylinder):** Determine brake power, mechanical efficiency, and thermal efficiency.
2. **Morse Test on Multi-Cylinder Petrol Engine:** Determine indicated power and mechanical efficiency of individual cylinders.
3. **Retardation Test on Diesel Engine:** Find frictional power using deceleration method.
4. **Heat Balance Test on Diesel/Petrol Engine:** Analyze energy distribution in various engine components.
5. **Performance Test on Variable Compression Ratio (VCR) Engine:** Study the effect of compression ratio on engine performance.
6. **Performance Test on 2-Stroke Petrol Engine:** Determine specific fuel consumption and efficiency.
7. **Emission Test using Exhaust Gas Analyzer or Smoke Meter:** Measure CO, CO_2, HC, NOx, and smoke levels from engine exhaust.
8. **Valve Timing and Port Timing Diagrams:** Plot and analyze the timing diagrams for 2-stroke and 4-stroke engines.
9. **Determination of Air-Fuel Ratio using Exhaust Gas Analysis:** Calculate the AFR based on chemical analysis of exhaust gases.

REFERENCES:

1. I.C. Engines Lab Manual – As per university guidelines (e.g., by department faculty or internal lab manuals).
2. Automobile Engineering – K.M. Gupta / Kirpal Singh.

INDUSTRIAL AUTOMATION LEVEL-II	
Course Code: 24CS0301D	
Credits: 1	
L T P : 0 0 2	
Prerequisite: None	

COURSE OBJECTIVES (CO)

- To acquaint students with the electrical connections for Industrial Automation
- To familiarize students with the connections of multiple actuators and sensors
- To acquaint students with the process of advanced PLC programming
- To make students understand the basic concepts of HMI
- To familiarize students with Industrial Robots and its scope in Industry 4.0

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to demonstrate:

- The understanding of advances of Industrial Automation
- The principles of sensors and their outputs to control multiple actuators
- The process of PLC programming
- The understanding of concepts of HMI
- The operation of Industrial Robotics and Industry 4.0

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					
CO5					

COURSE CONTENTS

Level-2 Experiments

1. Aim: To learn Electrical Circuit Construction for industrial automation
   - Methodology: Construct basic electrical circuits using breadboards, resistors, LEDs, and power sources, and measure current and voltage.

2. Aim: To learn formation of Complex Pneumatic Systems containing multiple actuators
    - Methodology: Design and build complex pneumatic circuits with multiple actuators and sequence control, and troubleshoot common issues.
3. Aim: To learn Hydraulic Control Systems
    - Methodology: Implement proportional control in hydraulic systems, use proportional valves, and analyze the system response.
4. Aim: To learn Sensor Integration Techniques
    - Methodology: Integrate multiple sensors into a single system, program data fusion techniques, and analyze combined sensor data for decision-making.
5. Aim: To learn Advanced Object Detection
    - Methodology: Implement an object detection system using a camera and image processing software, and program it to identify and track objects.
6. Aim: To learn Advanced PLC Programming for Automation
    - Methodology: Write complex PLC programs for automating multi-step processes, use timers and counters, and implement fault detection.
7. Aim: To learn Advanced HMI Design
    - Methodology: Develop dynamic HMI screens with real-time data display and control, implement user interactions, and handle alarms and events.
8. Aim: To learn Robotics Teaching
    - Methodology: Program a robotic arm for complex tasks, implement motion planning algorithms, and integrate sensors for enhanced functionality.
9. Aim: To get acquainted with Industry 4.0
    - Methodology: Learn the key concepts of Industry 4.0, explore a simple simulation of an Industry 4.0 system, and discuss its applications.

PRESENTATION SKILLS	
Course Code: 23SS553	
Credits : 3	
L T P : 0 0 2	
Prerequisite : NIL	

Training Objectives (TO):-

- To develop the public speaking skills in the student.
- To make the students learn and adapt to the necessary etiquettes required to work and grow in corporate culture.
- To make the student learn to speak in a debate session by putting his arguments and making others accept his viewpoint convincingly.

Training Learning Outcomes (TLO): -

After the completion of the training, the student will have ability:

- TLO1. To be confident in presenting himself infront of audience.
- TLO2. To become professional in his approach towards work culture.
- TLO3. To enhance the level of communication skills while interacting with others.

Mapping Matrix of Training Objectives (TO) & Training Learning Outcomes (TLO)			
Training Learning Outcomes (TLO) Training Objectives (TO)	TLO1	TLO2	TLO3
TO1			
TO2			
TO3			

Unit	Course Contents	Student Engagement Activity
Unit-I	Presentation Skills • Importance of presentation skills • 4 P’s of presentation skills – plan, prepare, practice & present • Guidelines for effective presentation	PPT Presentation Activity
Unit-II	Story Telling Skills • 4 P’s of story telling skills – people, place, plot & purpose • Types of story telling techniques • Importance of story telling skills	Start From Where I Stopped Activity
Unit-III	Corporate Culture Etiquettes • Importance of professional behaviour at work place • Understand & implementation of etiquettes at work place • Importance of values & ethics • Types of professional / corporate etiquettes	Etiquettes Role Play Activity
Unit-IV	Debate / Extempore • Difference between debate, extempore & group discussion • Learning argument /counter argument in debate • Role of verbal & non verbal communication in debate / extempore • Importance of current affairs / general knowledge	Current Affair Topic Speech Activity
Unit-V	Art of Creating Impression • Importance of creating first impression • 6 ways to master the art of creating impression	Speech Activity

Learning Resources	
Text Book	*Communication Skills* by Sanjay Kumar & Pushp Lata: Oxford University Press, 2018.
Reference Book	*Personality Development & Communication Skills-1* by C B Gupta: Scholar Tech Press, 2019. (ISBN No. – 9382209131)

Pedagogy

- The training will be based on the concept of learning by practice.
- The training will involve 30% of the training time on briefing and demonstration & the remaining 70% will be focusing on student’s engagement in training activities.
- The training will follow a circular approach where students are engaged, evaluated, given feedback and then re engaged.

Internal (Continuous Assessment & Evaluation) & End Term (Assessment & Evaluation) for Teamwork & Interpersonal Skills

Unit No.	Unit Name	Internal Assessment Parameter	Internal Marks (70)	End Term Assessment Parameters	End Term Marks (30)
1	Presentation Skills	Presentation Activity	20	Written Test	10
2	Story Telling Skills	Speech Activity	15		
3	Corporate Culture Etiquettes	Assignment	10		
4	Debate/Extempore	Speech Activity	15	Viva	20
5	Art of Creating Impression		10		

LIVE PROJECTS – II & INTERNSHIP	
Course Code: 23LP551	
Credits: 1	
L T P : 0 0 1	
Prerequisite: Nil	

INDUSTRIAL INTERNSHIP OBJECTIVES (IIOs):

4. To carry out the project assigned to the students.
5. To learn the specific skills and production processes.
6. To learn the importance of team work, safety and work culture.

INDUSTRIAL INTERNSHIP LEARNING OUTCOMES (IILOs):

The student should be able to:

5. Demonstrate the project assigned and its real-life applications
6. Demonstrate the specific skills learned and in-depth understanding of production processes.
7. Demonstrate team work, designing, planning, and organizing of project implementation and work culture of Industry.
8. Demonstrate cleanliness and safety.

MAPPING MATRIX OF THE IIOs AND IILOs:

INDUSTRIAL INTERNSHIP OBJECTIVES	INDUSTRIAL INTERNSHIP LEARNING OUTCOMES			
	IILO 1	IILO 2	IILO 3	IILO 4
IIO 1	?			
IIO 2		?		
IIO 3			?	?

SEMESTER – VI

THEORY OF MACHINES-II	
Course Code: 23ME601	
Credits: 3	
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

The students will be able to

1. To Know the basics of mechanism and perform kinematic analysis.
2. To Calculate the velocity and acceleration for 4-bar and slider crank mechanism
3. To Deduce the number of teeth in gears and torque transmitted in epicyclic gear trains. Apply gyroscopic couple in different transportation vehicles.
4. To Balance rotating and reciprocating masses in engines.
5. To Construct various cam profiles based on follower motion and perform kinematic analysis.

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion ofcourse, students would be able to:

1. The student is expected to be familiar with broader areas of basic mechanisms, velocity and acceleration of simple mechanisms.
2. An understanding of, Drawing the profile of cams and its analysis.
3. The student would be able to learn the fundamental concepts on Gear & gear train calculations.
4. An understanding of Balancing of machines.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	?			
CO 02	?			
CO 03			?	
CO 04				?
CO 05		?		

COURSE CONTENTS

Unit-I : Synthesis of Mechanisms: Number synthesis – Grubler's criteria, function generation to co-ordinate displacements of input and output links, Chebyshev spacing of accuracy points, Freudenstein equation, function generation with three accuracy points for four bar mechanism and slider crank mechanism.

Unit-II : Cams- classification of cams and followers, terminology for radial cams, types of follower motion –displacement, velocity and acceleration diagrams, synthesis of profiles of radial cams for radially translating and offset translating follower.

Gyroscopes: Gyroscopic forces, couple, precessional angular motion Gyroscopic effects on aeroplane and ship Tutorial on gyroscopic effect on two and four wheelers.

Unit-III : Dynamics of direct acting engine mechanism- displacement, velocity and acceleration of piston, D'Alemberts principle- inertia force and inertia torque, piston effort and crank effort, inertia of connecting rod, turning moment diagrams, fluctuation of speed and energy, flywheels, flywheels for punching press and design of rim type flywheel

Governors- Types of governors, Watt, Porter, Hartnell and Hartung governors; characteristics of centrifugal governors-controlling force, stability, sensitiveness isochronism, capacity and coefficient of insensitiveness; effort and power of governors.

Unit-IV : Gyroscopic effects- Precessional motion and angular acceleration, gyroscopic couple, some typical cases illustrating gyroscopic action –effect on naval ship, stability of two wheel and four wheel vehicles.

Unit-V : Balancing of rotating masses-static and dynamic balancing, two plane balancing. Balancing of several masses rotating in the same plane and balancing of several masses rotating in different planes.

Balancing of reciprocating masses –identification of inertia, forces for reciprocating masses in engine mechanisms, partial primary balancing of single cylinder engines and locomotives, balancing of multi cylinder engines, V-twin engines and radial engines-direct and reverse crank methods.

Text Book

1. Rattan, S.S., *Theory of Machines*, Tata McGraw Hill Publishing company Ltd., 2 nd Edition ,2005
2. Thomas Bevan, *Theory of Machines*, CBS Publishers and Distributors, 3rd Edition, 1984.

Reference Book and other materials

1. *Kinematics and dynamics of machinery:* Wilson and Sadler, Third edition, Pearson.
2. *Theory of Mechanisms and Machines:* Amitabh Ghosh and Ashok Kumar Mallik, Third Edition Affiliated East-West Press.
3. *Theory of Machines and Mechanisms*: Joseph Edward Shigley and John Joseph Uicker, Jr. Oxford University Press *Kinematics and dynamics of machinery:* R L Norton, McGraw Hill.

ADITIVE MANUFACTURING	
Course Code: 25ME602	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To know about Additive Manufacturing Technology
2. To know about Data Processing for Additive Manufacturing Technology.
3. To know about Process, advantages and applications, Three-Dimensional Printing.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course, student should be able

1. To understand about Additive Manufacturing Technology – Tooling – Applications.
2. To understand about Data Processing for Additive Manufacturing Technology: CAD model preparation.
3. To understand about Principles of SLS process – Process, advantages and applications, Three-Dimensional Printing.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES		
	CLO 1	CLO2	CLO3
CO1		⍰	
CO2			⍰
CO3	⍰		

Unit I-Introduction

Overview – History – Need-Classification -Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology – Tooling – Applications.

Unit II- Cad & Reverse Engineering

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation –Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.

Unit III-Liquid Based and Solid Based Additive Manufacturing Systems

Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications – Solid based system –Fused Deposition Modeling – Principle, process,advantages and applications, Laminated Object Manufacturing

Unit IV-Powder Based Additive Manufacturing Systems

Selective Laser Sintering – Principles of SLS process – Process, advantages and applications, Three Dimensional Printing – Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

Unit V- Medical and Bio-Additive Manufacturing

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing-Computer Aided Tissue Engineering (CATE) – Case studies

Text Books

1. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.

References

1. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
3. Hilton P.D. and Jacobs P.F., “Rapid Tooling: Technologies and Industrial Applications”, CRC press, 2000.
4. Dougles Bryden, “CAD and Protyping for Product Design”, 2014.

INDUSTRY 4.0	
Course Code: 23ME603	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

- Introduce students to the fundamentals of smart manufacturing and Industry 4.0
- Introduce concepts of smart manufacturing and Industry 4.0 in manufacturing industries
- To expose students to advanced concepts like Robotic automation, mobile computing and cyber security, Industry 4.0

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

- The scope of Industry 4.0 and its applicability in Indian Industry.
- The conceptual framework and road map of Industry 4.0
- Requirement of Robotic technology and Augmented reality for Industry 4.0
- The obstacles and framework conditions for Industry 4.0
- Advantages of machine integration for Industry 4.0

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	COL 1	COL 2	COL 3	COL 4	COL 5
CO 1	✓				
CO 2		✓		✓	
CO 3			✓		✓
CO 4					
CO 5					

COURSE CONTENTS

Unit-I: Introduction to Industry 4.0

Introduction, core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, current state of industry 4.0, Technologies.

Unit-II: Concept and framework for industry 4.0

Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.

Unit- III: Technology roadmap for industry 4.0

Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.

Unit-IV: Related disciplines for enabling industry 4.0

Robotic Automation and Collaborative Robots-Support System for Industry 4.0-Mobile Computing-Related Disciplines- Cyber physical Systems -Cyber Security.

Unit-V: Other applications and case studies

Opportunities and Challenges- Works and Workers for Industry 4.0-Strategies for competing in an Industry 4.0 -Industrial Applications-Case studies from HKPolyU students.

TEXT BOOKS

1. Anand Nayyar; Akshi Kumar, A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development, Springer Nature, ISBN: 978-3-030-14543-9, Switzerland, 2020.
2. G. R. Kanagachidambaresan, R. Anand, E. Balasubramanian, V. Mahima, Internet of Things for Industry 4.0: Design, Challenges and Solutions, Springer Nature, ISSN-2522- 8609, Switzerland, 2020

REFERENCE BOOKS

1. Bartodziej, Christoph Jan,”The Concept Industry 4.0”.
2. Alp Ustundag and Emre Cevikcan,”Industry 4.0: Managing the Digital Transformation”.
3. Klaus Schwab,”The Fourth Industrial Revolution”.
4. Christian Schröder, “The Challenges of Industry 4.0 for Small and Medium-sized Enterprises”.

REFRIGERATION AND AIR CONDITIONING	
Course Code: 23ME604	
Credits: 3	
L T P: 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

The students will be able to

1. To understand the Vapour compression and vapour absorption system Operation.
2. To know about the refrigeration cycles and methods for improving their Performance
3. To understand the components of refrigeration systems.
4. To know about the working and applications of refrigerator and air-conditioning systems.

Course Learning Outcomes (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion ofcourse, students would be able to:

1. Identify and know about the vapour compression and vapour absorption system operation, Cycle analysis and method for improving performance,
2. Understand Various components of refrigeration systems,
3. The student is expected to be familiar with the Design of air conditioning systems by cooling load calculations.
4. Application of refrigeration and air conditioning systems.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	?	?		
CO 02		?	?	
CO 03		?		
CO 04			?	?

UNIT-I: VAPOUR COMPRESSION REFRIGERATION SYSTEMS

Review of thermodynamic principles of refrigeration- Simple vapour compression system – analysis -Method for improving COP – Multistage and multiple evaporator system - Cascade system – COP comparison

UNIT-II: ABSORPTION REFRIGERATION SYSTEMS

Absorption refrigeration cycle - Water lithium bromide systems – ammonia absorption refrigeration system – COP calculation of single effect absorption system – Refrigeration absorbent combinations-comparison of absorption system with vapour compression systems.

UNIT-III: REFRIGERATION EQUIPMENTS & CONTROL

Compressors – Condensers and Cooling Towers-Evaporators-Expansion devices. **Refrigerants**: properties – selection of refrigerants-alternate refrigerants. Refrigeration plant controls-Testing and charging of refrigeration units.

UNIT-IV: DESIGN OF AIR CONDITIONING SYSTEMS

Different heat sources - Conduction and radiation load-occupants load - Equipment load- fresh air load-infiltration-air load- estimation of total load, bypass factor consideration-effective sensible heat factor (ESHF)-cooling coils and dehumidifier air washers.

UNIT-V: APPLICATION OF REFRIGERATION AND AIR CONDITIONING SYSTEMS

Preservation of different products-ice factory-dairy plant refrigeration systems-air conditioning of hotels and restaurants-air conditioning of theatres and auditorium-air conditioning of hospitals.

TEXT BOOK

1. Arora, S. C. and Domkundwar, S., *A course in Refrigeration and Air conditioning*, Dhanpat Rai (P) Ltd., New Delhi, 1997.
2. Khurmi R.S., and Gupta, J. K., *A text book of Refrigeration and Air Conditioning*, Eurasia Publishing housing (P) Ltd, New Delhi, 2002.

REFERENCE BOOK AND OTHER MATERIALS

1. Manohar Prasad, *Refrigeration and Air conditioning*, New Age International (P) Ltd, New Delhi, 1999.
2. Stoecker, W. F. and Jones J. W., *Refrigeration and Air Conditioning*, Tata McGraw Hill, New Delhi, 1986.
3. Roy J. Dossat, *Principles of Refrigeration*, Pearson Education Asia, 4^{th} edition, 2001.

Arora, C. P., *Refrigeration and Air Conditioning*, Tata McGraw Hill, New Delhi, 2002.Total Quality Management

THEORY OF MACHINES LAB	
Course Code: 23ME651	
Credits: 1	
L T P : 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To Analyze the effect of vibration and noise
2. To learn the usage of the laws governing the kinematics and dynamics of Machines.
3. To study about the gears and gear trains.
4. To study about the CAM.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1. Understand and use various types of gears and gear trains.
2. Understand and verify the laws governing the dynamics of machines
3. Understand the case studies on the field of Vibration
4. Understand the CAM and their applications.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01			✓	
CO 02		✓		
CO 03	✓			
CO 04				✓

LIST OF EXPERIMENTS

Experiment 1: Measurement of amplitude, velocity and acceleration using vibration pick-ups.

Experiment 2: To Measure the strain.

Experiment 3: Measurement of cutting forces using Drill, Lathe and Milling Dynamometers.

Experiment 4: Determination of moment of inertia of systems.

Experiment 5: Study of gear parameters

Experiment 6: Kinematics of gear trains – simple, compound, epicyclic, differential.

Experiment 7: CAM Analysis – angle Vs displacement and jump phenomenon.

Experiment 8: Governors - determination of characteristics and sensitivity.

Experiment 9: Vibration analysis of mechanical systems.

Experiment 10: Tensional vibration rotor systems.

Experiment 11: Balancing of rotating masses.

Experiment 12: Whirling of shaft.

Experiment 13: Diagnostics and field measurement of vibrations.

Experiment 14: Gyroscope

Note: *Any 8 experiments will be offered.

Text Book :Laboratory Manual.

DATA ANALYTICS TOOLS	
Course Code: 24CS0302D	Continuous Evaluation: ....Marks
Prerequisite: NIL	End Semester Examination:....... Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVE
1. To provide an overview of an exciting field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSQL MapReduce
3. To learn the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.

TRAINING LEARNING OUTCOMES (TLO)
After completion of TRAINING, students would be able to:
1. Understand the vision of Big Data from a global context.
2. To understand and apply Hadoop in Market perspective of Big Data.
3. To evaluate the application of Big Data in Industrial and Commercial Building Automation, evaluating Big Data performance using MapReduce and Real-World Design Constraints.
4. Applying and analyzing architecture and APIs with use of Devices, Gateways and Data Management in Big data.

TRAINING LEARNING OUTCOME (TLO)-TRAINING OBJECTIVE (TO) MAPPING

	TLO1	TLO2	TLO3	TLO4
TO1	?			
TO2		?	?	
TO3				?

TRAINING CONTENTS

MODULE	TRAINING CONTENTS	STUDENTS ENGAGEMENT ACTIVITY
I	BIG DATA Definition with Real Time Examples, How Big Data is generated with Real Time Generation, Use of Big Data-How Industry is utilizing Big Data, Future of Big Data.	Real life examples illustrated with discussion on Significance of Big Data
II	HADOOP Why Hadoop? What is Hadoop? Hadoop vs RDBMS, Hadoop vs BigData, Anatomy of a Hadoop cluster.	Students are trained on how to work on Hadoop
III	MAPREDUCE Theory, Data Flow (Map – Shuffle - Reduce), MapRed vs MapReduce APIs	Evaluating the application of Big Data in Industrial and Commercial Building Automation, evaluating Big Data performance using MapReduce and Real-World Design Constraints.
IV	HIVE AND PIG Architecture, Installation, Configuration, Hive vs RDBMS, Why Pig, Use case of Pig, Pig Components, Data Model.	Building and create state of the art architecture in Big Data. Hadoop, Creating projects and research activities based on Pig& Hive

LEARNING RESOURCES
• Gelman, Andrew, and Jennifer Hill. Data Analysis Using Regression and Multilevel/Hierarchical Models. 1st ed. Cambridge, UK: Cambridge University Press, 2006. ISBN: 9780521867061.
• Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin. Bayesian Data Analysis. 2nd ed. New York, NY: Chapman & Hall, 2003. ISBN: 9781584883883
• Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data” by EMC Education Services
• Analytics: Data Science, Data Analysis and Predictive Analytics for Business” by Daniel Covington.
• Machine Learning for Big Data: Hands-On for Developers and Technical Professionals” by Jason Bell.

PROFESSIONAL SKILLS	
Course Code: 23SS654	
Credits: 1	
L T P : 0 0 2	
Prerequisite: Nil	

Training Objectives (TO): -

- To encourage students to learn and apply the effective writing skills.
- To make the students learn various types of business correspondence letters, cover letters & resume.
- To encourage students to learn as to how to talk and convince people in GD & interview.
- To make the students learn to build rapport for building positive relationships professionally at workplace.

Training Learning Outcomes (TLO): -

After the completion of the training, the student will have ability:

- To understand the importance of professional writing required in workplace.
- To explore different formats in resume, cover letters & other business-related letters.
- To develop knowledge, skills and understanding people in-group and individually.
- To apply communication strategies either in-group or one on one basis and will be confident to lead the discussion among them.

Mapping Matrix of Training Objectives (TO) & Training Learning Outcomes (TLO)				
Training Learning Outcomes (TLO) Training Objectives(TO)	TLO1	TLO2	TLO3	TLO4
TO1				
TO2				
TO3				
TO4.	-	-	-	

Unit	Course Contents	Student Engagement Activity
Unit-I	Email Writing • Importance of email communication skills • Basic rules of effective email writing • Structure of email – address, subject, message text, attachments, signature	Email Practice Activity

Unit-II	**Resume Writing** • Difference between Resume, CV & Bio data • Guidelines of resume writing • Resume preparation of the student	Resume Making Activity
Unit-III	**Cover Letter Writing** • Objective of cover letter writing • Types of cover letters • Format & content of the cover letter	Cover Letter Practice Activity
Unit--IV	**Other Business Letters Writing** • Application Letters • Acknowledgement Letters • Complaint Letters • Memos	Letter Writing Practice Activity

Learning Resources	
Text Book	*Communication Skills* by Sanjay Kumar & Pushp Lata: Oxford University Press, 2018.
Reference Book	*Personality Development & Communication Skills-1* by C B Gupta: Scholar Tech Press, 2019.(ISBN No. – 9382209131)

Pedagogy

- The training will be based on the concept of learning by practice.
- The training will involve 30% of the training time on briefing and demonstration & the remaining 70% will be focusing on student's engagement in training activities.

The training will follow a circular approach where students are engaged, evaluated, given feedback and then re engaged.

Internal (Continuous Assessment & Evaluation) & End Term (Assessment & Evaluation) for Professional Writing Skills

Unit No.	Unit Name	Internal Assessment Parameter	Internal Marks (70)	End Term Assessment Parameters	End Term Marks (30)
1	Email Writing	Written Assignment	15	Written Test	10
2	Resume Writing		20		
3	Cover Letter Writing		15		
4	Other Business Letters Writing	Written Assignment	20	Viva	20

LIVE PROJECTS – III & INDUSTRIAL VISITS	
Course Code: 23LP651	
Credits: 1	
L T P : 0 0 1	
Prerequisite: Nil	

INDUSTRIAL INTERNSHIP OBJECTIVES (IIOs):

7. To carry out the project assigned to the students.
8. To learn the specific skills and production processes.
9. To learn the importance of team work, safety and work culture.

INDUSTRIAL INTERNSHIP LEARNING OUTCOMES (IILOs):

The student should be able to:

9. Demonstrate the project assigned and its real-life applications
10. Demonstrate the specific skills learned and in-depth understanding of production processes.
11. Demonstrate team work, designing, planning, and organizing of project implementation and work culture of Industry.
12. Demonstrate cleanliness and safety.

MAPPING MATRIX OF THE IIOs AND IILOs:

INDUSTRIAL INTERNSHIP OBJECTIVES	INDUSTRIAL INTERNSHIP LEARNING OUTCOMES			
	IILO 1	IILO 2	IILO 3	IILO 4
IIO 1	✓			
IIO 2		✓		
IIO 3			✓	✓

SEMESTER VII

ENGINEERING METROLOGY AND INSTRUMENTATION	
Course Code: 23ME701	
Credits : 3	
L T P : 3 0 0	
Prerequisite : NIL	

COURSE OBJECTIVES

To make the student to understand

1. Various comparative measurements.
2. Fundamentals of gears, thread measurements and measurements of surface finish.
3. Principle of light wave interference and applications of light wave interference for measurements.
4. To know about Control chart techniques in quality control.
5. Purpose and use of sampling and its benefits.

COURSE LEARNING OUTCOMES (CLOs)

Upon successful completion of the course the students will be able to

1. Analyze the principle of different metrology instruments
2. Reduce various components on machine tools and carryout dimensional measurement.
3. Demonstrate the terminology and its application of interference of light wave.
4. Perform the available different precision instruments in the field of measurement.
5. Quantify the measurement uncertainty along with Quality.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-I: INTRODUCTION TO METROLOGY

Basic Concepts - Legal Metrology - Precision - Accuracy - Types of errors - Linear and Angular Measurements - Standards of Measurements - Slip gauges - Calibration - Interchangeability and selective assembly. Introduction to Comparators - Types of Comparators - Mechanical, Mechanical – Optical, Electrical and Electronic, pneumatic, Fluid Displacement - Automatic gauging machines. Co ordinate Measuring Machine.

Unit- II: SCREW THREAD – GEAR MEASUREMENTS – SURFACE FINISH

Internal and External screw threads: Measurements of various elements of thread - Best size wire - Two and three wire method. Gear: Measurements of various elements - Constant chord method - Base tangent method. Surface Finish: Surface topography definitions - Measurement of Surface Texture - Methods - Evaluation of Surface finish.

Unit-III: INTERFEROMETRY

Principle of light wave interference - Light sources - Types of Interferometers - Michelson, Twyman Green Specialisation of Michelson, NPL flatness Interferometers, The Pitter NPL gauge - laser interferometer. Measurement of straightness - Flatness - squareness - parallelism - circularity - and Rotation.

Unit-IV: STATISTICAL QUALITY CONTROL

Introduction - Definition of Quality - Chance Causes and assignable Causes - SQC Benefits and Limitations. Fundamental concepts in probability - Normal curve - Measures of Dispersion - Distributions - Binomial, Poisson, Geometric, Hyper geometric, Poisson as an approximation to Binomial, Normal as an approximation to Binomial.

Unit-V: ACCEPTANCE SAMPLING

Basic Concepts and OC curve - AQL - LTPD - AOQL - Sampling Plans - Simple - Double - Multiple and sequential sampling plans - stratified sampling plans for variables. Related problems using BIS code books.

TEXT BOOK:

1. K. Duraivelu & S. Karthikeyan, Engineering Metrology and measurement, University Press, New Delhi, 2018.
2. Jain. R. K., *Engineering Metrology*, Khanna Publishers, New Delhi, 1987.
3. Gupta. R. C., *Statistical Quality Control*, Khanna Publishers, New Delhi, 1994.

REFERENCE BOOK AND OTHER MATERIALS

1. Doeblin, E. O., *Measurement System Applications and Design*, 1st Edition McGraw Hill, London, 1990.
2. Grant E. L., *Statistical Quality Control,* McGraw Hill, New York, 1984.
3. Gaylor, Shotbolt and Sharp, *"Metrology for Engineers ", O.R.Cassel, London, 1993.*

PNEUMATICS AND HYDRULICS SYSTEMS	
Course Code: 25ME702	
Credits : 3	
L T P : 3 0 0	
Prerequisite : NIL	

COURSE OBJECTIVES

To make the student to understand

- To understand the basics of fluid power systems and their components.
- To design hydraulic and pneumatic circuits for industrial applications.
- To analyze the performance of fluid power systems and their control.

COURSE LEARNING OUTCOMES (CLOs)

Upon successful completion of the course the students will be able to

- Explain the working principles of fluid power components.
- Design and troubleshoot fluid power circuits.
- Apply knowledge in industrial automation, control, and machinery design.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES		
	CLO1	CLO2	CLO3
CO1	✓		
CO2		✓	
CO3			✓

COURSE CONTENTS

UNIT I: Introduction to Fluid Power

- Overview of fluid power systems
- Applications and advantages of hydraulic and pneumatic systems
- Properties of hydraulic fluids
- Pascal’s Law, Bernoulli’s Equation, Continuity Equation
- Energy losses in hydraulic systems

UNIT II: Hydraulic System Components

- Hydraulic pumps: gear, vane, and piston pumps
- Actuators: hydraulic cylinders and motors
- Directional control valves, pressure control valves, and flow control valves

- Accumulators and filters
- Hydraulic circuits: single/double-acting cylinder circuits, regenerative, meter-in/meter-out circuits

UNIT III: Pneumatic System Components

- Compressors: types and applications
- Pneumatic actuators: cylinders and motors
- Directional, pressure, and flow control valves
- Air preparation units (FRL – Filter, Regulator, Lubricator)
- Pneumatic circuit design and control strategies

UNIT IV: System Design and Control

- Basic hydraulic and pneumatic circuit design
- Sequencing and logic control using valves
- Electro-hydraulic and electro-pneumatic systems
- Ladder diagrams and PLC integration basics

UNIT V: Maintenance and Troubleshooting

- Maintenance of hydraulic and pneumatic systems
- Safety precautions and standard practices
- Common faults, diagnosis, and troubleshooting techniques
- Case studies from industries (automation, robotics, CNC machines)

TEXT BOOKS:

1. Fluid Power with Applications – Anthony Esposito.
2. Hydraulics and Pneumatics – Andrew Parr.
3. Pneumatic Systems: Principles and Maintenance – S.R. Majumdar.

REFERENCE BOOKS:

1. Oil Hydraulic Systems – Principles and Maintenance – S.R. Majumdar.
2. Industrial Hydraulics – J.L. Iliff.
3. Hydraulic and Pneumatic Controls – K.S. Srinivasan.

ENGINEERING METROLOGY AND INSTRUMENTATION LABORATORY	
Course Code: 23ME751	
Credits : 1	
L T P : 0 0 2	
Prerequisite : NIL	

COURSE OBJECTIVES (COs)

To make the student to understand

1. To know the standards of measurement & calibration of measuring instruments.
2. Use geometrical relations to find out the different measurements of different parameters.
3. Learn the main principle on which different instruments operate and provide hands on experience on them.
4. Generate knowledge and skill in use of precision instruments.
5. Learn a basic understanding of various instruments used in linear and angular Measurements.

COURSE LEARNING OUTCOMES (CLOs)

After completion of the course student will be able to:

1. Develop quality standards of engineering products in industries.
2. Demonstrate work in quality control departments of industries and to ensure quality of products.
3. Analyze the measurement of the surface roughness and perform alignment tests.
4. Develop the ability to apply the principles in instruments and measuring techniques.
5. Demonstrate work in designing the instrumentation for a particular purpose and special purpose devices.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5	✓		✓		✓

LIST OF EXPERIMENTS

1. Use of Precision Measuring Instrument (Linear Measurement)
2. Use of Angle Measuring Instrument (Sine bar, Sine Center)
3. Measurement of tooth thickness by gear tooth vernier
4. Calibration of Dial gauge, Micrometer etc.
5. Taper and Bore Measurement using Spheres
6. Measurement of Angles between centerlines of holes drilled radially on a shaft
7. Process capability study using mechanical Comparator
8. Checking the dimension of a part using slip gauge.
9. Measurement using Pneumatic Comparator
10. Fundamental dimension of a gear using profile projector.
11. Testing the square ness of a try square using slip gauge.
12. Study Experiments:
    - Checking the straightness using auto collimator
    - Measurement of thread parameters using floating carriage micrometer
    - Measurement of surface roughness using roughness tester

TEXT BOOK:

1. Laboratory Manual

REFERENCE BOOK AND OTHER MATERIALS:

1. Jain. R. K., *Engineering Metrology*, Khanna Publishers, New Delhi, 1987.
2. Gupta. R. C., *Statistical Quality Control*, Khanna Publishers, New Delhi, 1994.

LIVE PROJECTS – IV & INTERNSHIP	
Course Code: 23LP751	
Credits: 1	
L T P : 0 0 1	
Prerequisite: Nil	

INDUSTRIAL INTERNSHIP OBJECTIVES (IIOs):

1. To carry out the project assigned to the students.
2. To learn the specific skills and production processes.
3. To learn the importance of team work, safety and work culture.

INDUSTRIAL INTERNSHIP LEARNING OUTCOMES (IILOs):

The student should be able to:

1. Demonstrate the project assigned and its real-life applications
2. Demonstrate the specific skills learned and in-depth understanding of production processes.
3. Demonstrate team work, designing, planning, and organizing of project implementation and work culture of Industry.
4. Demonstrate cleanliness and safety.

MAPPING MATRIX OF THE IIOs AND IILOs:

INDUSTRIAL INTERNSHIP OBJECTIVES	INDUSTRIAL INTERNSHIP LEARNING OUTCOMES			
	IILO 1	IILO 2	IILO 3	IILO 4
IIO 1	?			
IIO 2		?		
IIO 3			?	?

MINOR PROJECT	
Course Code: 23ME752	
Credits: 4	
L T P : 0 0 4	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To provide comprehensive learning platform to students where they can enhance their employability skills and become job ready along with real corporate exposure.
2. To Increase self-confidence of students and helps in finding their own proficiency.
3. To cultivate student's leadership ability and responsibility to perform or execute the given task.
4. To provide learners hands on practice within a real job situation

COURSE LEARNING OUTCOMES (CLOs)

On successful completion of the minor project, the student will be able to,

1. Identify real world problems of mechanical engineering and related systems.
2. Interpret the working of mechanical engineering systems.
3. Apply the principles of mechanical engineering in real world systems.
4. Criticize and experiment to arrive at solutions for real world mechanical engineering problems.
5. Analyse and evaluate to obtain solution for problems in mechanical engineering systems.

MAPPING MATRIX OF MINOR PROJECT COURSE OBJECTIVES (COs) & MINOR PROJECT COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO 1	CLO2	CLO3	CLO4	CLO5
CO1	?				
CO2		?			
CO3			?		
CO4				?	?

SEMESTER VIII

MAJOR PROJECT	
Course Code: 23ME851	
Credits: 12	
L T P : 0 0 24	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To provide comprehensive learning platform to students where they can enhance their employability skills and become job ready along with real corporate exposure.
2. To Increase self-confidence of students and helps in finding their own proficiency.
3. To cultivate student's leadership ability and responsibility to perform or execute the given task.
4. To provide learners hands on practice within a real job situation

COURSE LEARNING OUTCOMES (CLOs)

On successful completion of the course, the student will be able to,

1. Identify real world problems of mechanical engineering and related systems.
2. Interpret the working of mechanical engineering systems.
3. Apply the principles of mechanical engineering in real world systems.
4. Criticize and experiment to arrive at solutions for real world mechanical engineering problems.
5. Analyse and evaluate to obtain solution for problems in mechanical engineering systems.

MAPPING MATRIX OF MAJOR PROJECT COURSE OBJECTIVES (COs) & MAJOR PROJECT COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO 1	CLO2	CLO3	CLO4	CLO5
CO1	?				
CO2		?			
CO3			?		
CO4				?	?

Specialization in Mechanical Engineering
Professional Elective Courses

Alternative Sources of Energy and System	
Course Code:23MEPE01	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)
1. To familiarize the students with the concept of Biomass
2. To familiarize the students with the concept of Solar Energy
3. To familiarize the students with the concept of Wind Energy OTEC
4. To familiarize the students with the concept of Fuel cells
5. To familiarize the students with the concept of MHD systems.

COURSE LEARNING OUTCOMES (CLO)
At the end of the course students will be able to,
1.To analyze the various renewable energy sources like wind, solar,
2. To analyze the various biomass, Ocean energy, Fuel cells and MHD systems.
3. Exposure on biomass gasification and combustion, Theory of flat plate collectors, photo voltaic, thermal applications and limitations of solar energy are also provided.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	
CO 03		✓	
CO 04			✓
CO 05			✓

COURSE CONTENTS

UNIT 1: BIOMASS
Biomass, sources of biomass - Fermentation, pyrolysis, gasification and combustion - Biogas, calorific value - Power generation, biogas plant design and operation. Thermo-chemical conversion of biomass – Energy balance, conversion to solid, liquid, and gaseous fuel.

UNIT II: SOLAR ENERGY

Solar radiation and its measurements. Flat plate collectors – Photovoltaic and thermal applications – Limitation of solar energy – Theory of flat plate collectors – Solar water heating, solar drying, solar stills, solar cooling and refrigeration.

UNIT III: WIND ENERGY

Basic principle of Wind energy conversion – Wind data and Energy Estimation – Site selection considerations – components of WECS – Advantages and disadvantages of WECS – Design consideration of horizontal axis Machines – Analysis of aerodynamic forces acting on the blade – Performance of wind Machines

UNIT IV: OCEAN ENERGY

Ocean Thermal Energy Conversion - Wave and tidal energy - Availability, geographical distribution - Power generation using OTEC - Scope and economics - Geothermal energy, availability.

UNIT V: ELECTROCHEMICAL ENERGY SOURCES - BATTERIES

Cell and batteries – types of batteries, Primary batteries – Lechalanche cell (dry cell), Lithium cell, Secondary batteries(Accumulators) – Lead acid battery, Alkaline battery Ni-Cd battery, , Lithium-ion battery, Fuel cells- H2 – O2 fuel cell & Methanol – Oxygen fuel cell, Photovoltaic Cell- Solar Cell.

TEXT BOOKS

1. Rai, G. D., Non-Conventional Energy Sources, Khanna Publishers, 4th edition, New Delhi, 2005.
2. Wakil, M. M. EL., Power Plant Technology, McGraw Hill Book Company, New York, 1984.

REFERENCE BOOKS

1. Soreyson, B., Renewable Energy, Academic Press, 1989.

Twidell, J. W. and Weir, A. D., Renewable Energy Resources, ELBS Publication, 1986.

Introduction to Sensors, Actuators & IoT	
Course Code:23MEPE02	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To make students know the IoT eco system.
2. To provide an understanding of the technologies and the standards relating to the Internet of Things.
3. To develop skills on IoT technical planning.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1. To understand the basics of Networking and Security.
2. To understand predecessor of IoT technology and emergence of Internet of Things.
3. To understand architecture for Internet of Things.
4. To recognize various devices, sensors, actuators, and various processing paradigms for IoT

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓

Course Content

UNIT - I

Basics of Networking & Basics of Network Security: Network Types, Layered Network Models, Addressing, Internet of Things TCP/ IP Transport layer, Security, Network Confidentiality, Message Integrity and Authenticity, Digital signatures, Key Management, Internet Security & Firewall.

UNIT - II

Predecessors of IoT & Emergence of IoT–Introduction, Wireless Sensor Networks, Machine-to-Machine Communications, Cyber Physical Systems, Architectural components of CPS, IoT versus M2M, IoT versus CPS, IoT versus WoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components, Addressing Strategies in IoT.

UNIT - III

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing

UNIT - IV

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations,
UNIT V Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing
Topologies, IoT Device Design and Selection Considerations, Processing Off loading, Off load location, Off load decision making, Off loading considerations.

Text Books:

1. Internet of Things, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, John Wiley & Sons.
2. Sudip Mishra, Anandarup Mukherjee, Arijit Roy: Introduction to IOT, Cambridge University Press.

Reference Books:

1. Bassi, Alessandro, etal, “Enablingthingstotalk”,Springer-VerlagBerlin-2016
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
3. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/ Maker Media Publishers.

Mechanical Behavior and Testing of Materials	
Course Code: 23MEPE03	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To familiarize students with the fundamental concepts of mechanical behavior of materials,
- To familiarize students with the fundamental concepts various mechanical testing
- To familiarize students with the fundamental concepts practices and to apply them to design the materials for various load-bearing structural engineering applications.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

- Understand the basics of elastic and plastic deformation
- Analyse the plasticity, dislocation and strengthening mechanisms
- Understand and analyse the tensile behaviour of materials and correlating with microstructures
- Understand fatigue and creep behaviour and evaluate & design materials for better creep and fatigue resistance

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	COL1	COL 2	COL3	COL 4
CO 1	√			
CO 2		√		√
CO 3			√	

COURSE CONTENTS

Unit-I

Elastic and plastic deformation, stress-strain relationship; plastic deformation of metallic materials, Mohr's circle, Yielding criterion- Von Misses, and maximum-shear-stress/Tresca yielding criterion, failure criteria under combined stresses

Unit-II

Elements of theory of plasticity, dislocation theory, properties of dislocation, stress fields around dislocations, elementary dislocation interactions; application of dislocation theory to work hardening and strengthening mechanisms.

Unit-III

Engineering stress-strain curve, true stress-strain curve, instability in tension, stress distribution at the neck, , testing machines, Tensile properties of important materials.

Unit-IV

Introduction, Brinell, Vickers and Rock well hardness tests, Meyer hardness, analysis of indendation by an indenter, relationship between hardness and the flow curve, microhardness tests, hardness conversion; hardness at elevated temperatures. Introduction to torsion, torsional stresses for large plastic strains, types of torsion failures torsion test vs. tension test, hot torsion testing.

Unit-V

Introduction to fatigue testing, practice and evaluation; fatigue crack growth; low cycle, high cycle fatigue; Introduction to creep; stress rupture testing; creep data extrapolation; fatigue-creep interactions; superplasticity.

Text Books

1. Dieter G. E., ‘Mechanical Metallurgy’, 3 rd Edition, McGraw Hill Publications, 2004
2. Dowling NE, Mechanical Behaviour of Materials, 4th Ed, Pearson, 2013

Reference Books

1. Hull, D., Bacon, D.J., Introduction to Dislocations, 5th Ed., Butterworth-Heinemann, 2011
2. Suryanarayana, AVK., ‘Testing of Metallic Materials’, BS Publications, 2018

Hydraulic Machine	
Course Code:23MEPE05	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To familiarize with conservation laws and dimensional analysis
2. To familiarize flow through closed conduits and hydraulic machines.
3. To familiarize hydraulic turbine.
4. To familiarize hydraulic pumps .

COURSE LEARNING OUTCOMES (CLO)

1. Student will be able to understand fluid principle
2. Student will be able to understand concept of IMPULSE TURBINE
3. Student will be able to understand concept of reaction turbine
4. Student will be able to understand concept of different type of pump
5.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

Course Content

Unit I

IMPACT OF FREE JETS Impulse – momentum principle, jet impingement - on a stationary flat plate, inclined plate and a hinged plate, at the center of a stationary vane, on a moving flat plate, inclined plate, a moving vane and a series of vanes, Jet striking tangentially at the tip of a stationary vane and moving vane(s), jet propulsion of ships.

Unit II

IMPULSE TURBINES Classification – impulse and reaction turbines, water wheels, component parts, construction, operation and governing mechanism of a Pelton wheel, work done, effective head, available head and efficiency of a Pelton wheel, design aspects, speed ratio, flow ratio, jet ratio, number of jets, number of buckets and working proportions,

Unit III

REACTION TURBINES Component parts, construction and operation of a Francis turbine, Propeller,

Kaplan turbine, differences between the Francis and Kaplan turbines, governing mechanism, work done by the turbine runner, working proportions and design parameters, slow, medium and fast runners, degree of reaction, inward/outward flow reaction turbines, construction and operation of a draft tube - its function and different forms, Introduction to new types of turbine, Deriaz (Diagonal), Bulb, Tubular turbines, Problems.

Unit IV

MODEL SIMILITUDE Performance Characteristics and governing of impulse turbines ,Performance Characteristics and Governing of reaction turbine Unit quantities, specific speed and model relationships for turbines, scale effect, cavitations – its causes, harmful effects and prevention, Thomas cavitation factor, permissible installation height, Problems.

Unit V

PUMPS Centrifugal Pumps: Classification, velocity vector diagrams and work done, Similarity relations and specific speed, net positive suction head, cavitation and maximum suction lift, performance characteristics. Brief introduction to axial flow, mixed flow and submersible pumps,

Reciprocating Pumps: Construction and operational details, discharge coefficient, volumetric efficiency and slip, work and power input, characteristic curves, centrifugal vs reciprocating pumps, brief introduction to screw, gear, vane and radial piston pumps.

Text Books :

1. Hydraulics & Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi

2. Hydraulic Machines – Jagdish Lal, Metropolitan

Reference Books :

1. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers

2. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill 3. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons

Industrial Engineering and Operations Research	
Course Code:23MEPE06	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To understand the concepts of Linear programming technique
2. To understand the applications and use of Assignment, Transportation and Replacement models
3. To familiarise with PERT and CPM technique
4. To familiarise with detailed knowledge of Inventory control and queing theory

COURSE LEARNING OUTCOMES (CLO)

Students completing this course will be able to,

1. Formulate real-world problems as a linear programming model and describe the theoretical workings of the graphical and simplex method
2. Understand different queuing situations and find the optimal solutions using models for different situations
3. Understand variety of problems such as assignment, transportation, travelling salesman etc
4. Understand the concept of Queuing Theory

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

COURSE CONTENTS

UNIT I- LINEAR PROGRAMMING Operations research and decision making - Types of mathematical models and constructing the model - Formulation of linear programming problem - Simplex method (Analytical & Graphical) - Two phase and Big M methods.

UNIT II- ASSIGNMENT AND TRANSPORTATION MODELS Assignment models - Transportation problem – North west corner method – Least cost method – Vogel's approximation method – Modi method, Unbalance and degeneracy in transportation model. Replacement theory.

UNIT III- SCHEDULING AND NETWORK ANALYSIS Problem of sequencing – Processing ‗n' jobs through two machines and three machines - Processing two jobs through ‗m' machines. Network analysis – PERT and CPM.

UNIT IV - Production Planning and Control

Objectives of PPC- Functions of PPC- Aspects of product development and design- Process Planning, Principles of Standardization, specialization, Simplification-Group Technology- Optimum Batch size, ABC analysis-Value engineering, Traceability, Inventory reconciliation.

UNIT V- QUEING THEORY Queing Theory: Poisson arrivals and exponential service times - Waiting time and idle time cost - Singlechannel, multi channel problem, Monte Carlo technique applied to Queing problems - Poisson arrivals and Service time.

TEXT BOOKS

1. Handy, A. Taha, Operations Research, 5th Edition, Prentice Hall of India, New Delhi, 1995.
2. Philip and Ravindran, “Operational Research ", John Wiley, 1992.

REFERENCE BOOKS

1. Premkumar, Gupta and Hira, Operation Research, S. Chand & Co., New Delhi, 1986.
2. Fredric S. Hilleer and Gerold J. Lieberman, Introduction to Operation Research, 2nd Edition, CBS, 1974.
3. J.K.Sharma, “Operations Research”. 6th Edition, Trinity

FLEXIBLE MANUFACTURING SYSTEMS

Course Code: 23MEPE07	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To introduce flexible manufacturing concepts.
2. To give exposure to the student to different types of advanced manufacturing processes, automated flow lines.
3. To study about group technology and Flexible manufacturing systems.
4. To study the use computers in the area of manufacturing to reduce manual processing and linking computers to all the manufacturing machines and increase the productivity, reduce the unnecessary costs.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

1. Understand different types of production system.
2. Identify how automation can be used in production systems.
3. Recall basic elements of automation, and automation strategies.
4. Apply group technology, cellular manufacturing concepts.
5. Design of flexible manufacturing cells and systems

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				
CO 2		√			
CO 3			√		
CO 4				√	
CO 5					√

COURSE CONTENTS

Unit-I PRODUCTION SYSTEMS

Types of production: Job Shop, Batch and Mass production, Functions in manufacturing, Organization and information processing in manufacturing, Plant layout, Batch production, Automation in Production system, Production quantity and product variety, Production rate, Production capacity, Utilization, Availability, Manufacturing lead time for all types of production, Work in progress inventory, Scheduling and its problems

Unit-II GROUP TECHNOLOGY

Introduction to GT, Formation of part families, Part classification - Coding system: Optiz, Multi Class and Production flow analysis, Machine cells design: Clustering methods, Modern algorithms, Benefits of GT, System planning, Objective, guide line, system definition and sizing, Human resources: Objective, staffing, supervisor role.

Unit-III FLEXIBLE MANUFACTURING SYSTEMS

Introduction, Evolution, Definition and Need for FMS, Need for Flexibility, Economic Justification of FMS-Application Criteria, Machine tool Selection and Layout, Computer control system, Data files, Reports, Planning the FMS, Sizing of FMS, Quantitative Analysis Methods for FMS, Bottle neck and extended Bottle neck model, Benefits and limitations.

Unit-IV FLEXIBLE MANUFACTURING CELLS

Introduction to manufacturing cell, Cell description and classifications, unattended machining, Component handling and storage system, Cellular versus FMS, System Simulation, Hardware configuration, PLC and Controllers, Communication networks, Lean production and agile manufacturing.

Unit-V FMS SOFTWARE

Introduction to FMS software, General Structure and requirements, Functional descriptions, Operational overview, Computer simulation, FMS installation, Objective, Acceptance testing, Performance goals and Expectations, Continued support.

Text Book

1.William W. Luggen, Flexible Manufacturing Cells and Systems, Prentice Hall, New Jersey, 1991.

2.Mikell P. Groover, Automation Production Systems &Computer Integrated manufacturing, Prentice Hall of India, New Delhi, 2007.

Reference Book

1.David J. Parrish, Flexible Manufacturing, Butterworth-Heinemann, Newton, MA, USA, 1990.

2.Buffa, E. S., Modern Production and Operation Management, New York, 1985.

3. Jha, N.K. " Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991

Metallurgical Waste Management	
Course Code:23MEPE08	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To familiarize with the waste produced in mining
2. To familiarize with ore beneficiation,
3. To familiarize with metallurgical operations, e-waste
4. To familiarize with utilization of waste and their management.

COURSE LEARNING OUTCOMES (CLO)

1. Student will be able to Identify the various kinds of wastes produced during mining,
2. Student will be able to Classify the wastes produced from iron making, steel making, plasma processing, hydrometallurgical processing.

3. Student will be able to Select a suitable methods to recycle the wastes produced during
4. Student will be able to Provide a solution for waste management through process integration and intensification

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

Course Content

Unit I

Environmental and health impacts of Mining and Metallurgical waste. Various kind of wastes: Mining and Beneficiation waste production. Ferrous metal waste production. Ferroalloys waste production. Hydrometallurgical waste production. Metal manufacturing and finishing waste production.

Unit II

Post consumer waste production. E-waste and recovery of metals and useful things from e-waste.

Utilization of mine overburden and waste rock. Potential utilization of mineral beneficiation tailings. Prevention and mitigation of acid mine drainage.

Unit III

Recycling and reuse of blast furnace ironmaking slags, steel making dusts and sludges. Utilization of steel making dusts – Plasma based processing, hydrometallurgical processing, solidification and stabilization. Recycling and reuse of steelmaking slags

Unit IV

Utilization of Jarosite, goethite produced during extraction of zinc, Utilization of red mud produced in Bayer process: metallurgical utilization through metal recovery, utilization in building and construction, Glass-ceramics and Pigments. Recycling and utilization of surface oxide scale produced during metal Forming operation. Metal recovery from pickling and plating sludges.

Unit V

Waste management and utilization options: zero waste process approach, synergy between residue Produces and residue end users. Process integration to mineral waste utilization. Process intensification.

Reference Books

1 Ndlovu, S., G.S. Simate and E. Matinde, Waste production and utilization in the Metal Extraction Industry, CRC Press, 2017

2 Ramachandra Rao, Resource recovery and recycling from metallurgical wastes, Elsevier, 2006

3 K. Hieronymi, R. Kahhat, E. Williams, E-waste Management: From waste to resource, Routledge, New York,2013

Power Plant Engineering	
Course Code:23MEPE09	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

Course Objective

The objective of course is to familiarise the students with thermodynamic cycles and various components of power plants.

Course Learning Outcomes

At the end of the course, the student will be able to,

1.Understanding of Thermal Power Plant Operation, turbine governing, different types of high pressure boilers including supercritical and supercharged boilers, Fluidized bed combustion systems.

2.Basic knowledge of Different types of Nuclear power plants including Pressurized water reactor, Boiling water reactor, gas cooled reactor, liquid metal fast breeder reactor.

3.Discussing environmental and safety aspects of power plant operation

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	✓

Unit I Indian energy scenario, Indian coals: formation, properties, analysis, benefication and heating value calculation of coals; coking and noncoking coals, fuel handling systems; coal gasification. Classification of power plants, base load and Peak load power stations, co-generated power plant, captive power plant, and their fields of application & selection criteria,.

Unit II Steam Generators: High pressure utility boiler, natural and forced circulation, fuel handling, coking and non-coking coal, coal benefication, coal pulverization, pulverized fuel firing system, combustion process, need of excess air, cyclone furnace, fluidized bed boiler, placement of evaporator, economizers, super heaters, re-heaters, air pre-heater in the boiler, de-aeration, boiler blow- down, ash collection by bag house, gravity separation, electrostatic precipitators and wet scrubbers, boiler efficiency calculations, water treatment: external and internal treatment

Unit III Combined Cycle Power Plants: Binary vapour cycles, coupled cycles, gas turbine- steam turbine power plant, gas pipe line control, MHD- Steam power plant, thermionic steam power plant, integrated coal combined cycle (IGCC) power plan

Unit IV Other power plants: Nuclear power plants - working and types of nuclear reactors, boiling water reactor, pressurized water reactor, fast breeder reactor, controls in nuclear power plants, hydro power plant -classification and working of hydroelectric power plants, tidal power plants, diesel and gas power plants.

Unit V Environment Pollution and Energy conservation: Economics of power generation: load duration curves, power plant economics, pollution from power plants, disposal/management of nuclear power plant waste, concept of energy conservation and energy auditing

TEXT BOOKS

1. Power Plant Engineering by M.M. Elwakil, Tata McGraw Hill, ISBN- 0070662746
2. Power Plant Engineering by P.K Nag, Tata McGraw Hill, ISBN- 0070435993.

REFERENCE BOOKS

1. Steam and Gas turbines by A Kostyuk and V Frolov, MIR Publishers, ISBN9785030000329.

Modern Power Plant Engineering by J Wiesman and R Eckart, Prentice hall India Ltd, ISBN-97801359725.

2. Planning Fundamentals of thermal Power Plants by F.S Aschner, John Wiley, ISBN- 07065159X.
3. Applied Thermodynamics by T.D Eastop and McConkey, Longman Scientific and Technical, ISBN- 0582305351.

SIMULATION MODELLING OF MANUFACTURING SYSTEMS

Course Code: 23MEPE10	
Credits: 3	
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (CO)

• To impart knowledge in the field of modern methods for simulation and modelling of production systems for industrial needs.

• To focus on technological processes and manufacturing systems and applies the principles of discrete simulation for their modeling using software tool.

• To familiarize with discrete event simulation for modelling & simulation of manufacturing systems.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1: Understand the basic concepts and applications of discrete event simulation

2: Analyze the simulation input data

3: Verify and validate simulation models using statistical techniques

4: Analyze and interpret the simulation output results CO5: Build credible simulation models for real-time applications

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			√
CO 2	√	√	√	
CO 3				√

Unit 1

Introduction: Introduction to manufacturing systems – Introduction to simulation – applications – System and System Environment – Types of Simulation, Plant and process simulation - Simulation procedure – Examples of simulation. Probability distributions: Review of basic probability and statistics – Probability distributions – Random number generators – Testing of Random numbers.

Unit 2

Analysis of Simulation input data: Data Collection – Statistical analysis of numerical data – Tests for Independence and Identically distributed data - Distribution fitting – selecting a distribution in the absence of data – Modelling discrete probabilities – Demonstration of input modelling using Arena

Unit 3

Simulation package. Model Building of Discrete systems: Modelling Paradigms - Modelling of Structural elements and Operational elements – Modelling issues – Model Verification and Validation.

Unit 4

Applications of Simulation in Manufacturing – Manufacturing Modelling Techniques – Modelling Material Handling system – Model building exercises using Arena - Case study. Simulation output analysis:

Unit 5

Design of Simulation Experiments: Determination of warm up period, Run length, Number of replications - Statistical analysis of simulation output – Terminating and Non-Terminating Simulations – Comparing alternative system designs – Variance reduction Techniques – Simulation Optimization.

Text Books

1. Law A. W. and Kelton D. W. - ‘Simulation Modeling and Analysis’ - McGraw Hill - 2010 - 5th Edition.
2. Kelton D. W., Sadowski R. P. and Sasowski D. A. - ‘Simulation with ARENA’ - McGraw Hill – 2009.

Reference Books

1. Banks J., Carson J. S., Nelson B. L. and Nicol D. M. - ‘Discrete Event System Simulation’ - Pearson Education - 2001 - 3rd Edition.
2. Viswanathan N. and Narahari Y. - ‘Performance Modeling of Automated Manufacturing Systems’ - Prentice Hall 1998

GAS DYNAMICS AND TURBOMACHINERY	
Course Code: 23MEPE11	
Credits : 3	
L T P : 3 0 0	
Prerequisite : NIL	

COURSE OBJECTIVES (COs)

The course aims at analysis of

1. To understand the effect of isentropic compressible flow through the variable duct such as nozzle and diffusers.
2. To acquaint the students with the compressible flow with features of normal shock application in real life situation.
3. To make the students understand the effect of compressible flow through a constant area duct with friction.
4. To make the students understand the effect of compressible flow through a constant area duct with heat transfer.
5. To understand basic fundamentals of turbomachines.

COURSE LEARNING OUTCOMES (CLOs)

Upon successful completion of the course the students will be able to

1. Design C-D nozzles by applying the concepts of isentropic compressible flow through variable area duct.
2. Analyze normal shock and expansion waves in high speed flows.
3. Apply the concepts of Fanno flow and Rayleigh flow towards the design of combustion sections and jet pipes.
4. Apply the knowledge of shock-shock interaction, shock reflection and Prandtl-Meyer expansion fan-shock interaction.
5. Explain Turbomachines and related terms.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-I: FUNDAMENTALS OF COMPRESSIBLE FLOW AND FLOW THROUGH VARIABLE AREA DUCTS

Energy equation for compressible fluid flow, various regimes of flow, reference velocities stagnation states, velocity of sound derivation, critical states, Mach number, Crocco number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility, equivalent of Bernoulli's equation for compressible flow. Isentropic flow through variable area ducts, T-S and h-s diagrams for nozzles and diffusers, area ratio as a function of Mach number, impulse function (no derivation), mass flow rate through nozzles and diffusers, non-dimensional mass flow rate in terms of pressure ratio (Flienger's formula).

Unit-II: FLOW WITH NORMAL SHOCK

Development of shock wave, governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the shock (no derivations), Prandtl - Meyer equation, impossibility of shock in subsonic flows, strength of a shock wave.

Unit-III: FLOW THROUGH CONSTANT AREA DUCTS

Flow in constant area ducts with friction (Fanno flow), Fanno curves and Fanno flow equations. Flow in constant area duct with heat transfer (Rayleigh flow), Rayleigh curves and Rayleigh flow equations.

Unit-IV: PRINCIPLES OF TURBOMACHINERY

Classification - specific work - representation of specific work in T-s and h-s diagrams– slip and its estimation – impulses and reaction type Machines – degree of reaction – effect of outlet blade angles on blade shape – model laws, specific speed and shape number – special features of hydro, characteristics of turbo Machines – cavitation, surge and stall – thin aerofoil theory.

Unit-V: STUDY OF TURBOMACHINES

Compressors – Axial and centrifugal type, Axial flow Turbines – Velocity triangles, performance (Elementary treatment only).

TEXT BOOK:

1. Yahya, S. M., *Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion*, Wiley Eastern, New Delhi, 1993.
2. Yahya, S. M., *Turbines, Fans and Compressors*, Tata McGraw Hill Publications, New Delhi,1996

REFERENCE BOOK AND OTHER MATERIALS

1. Shapiro, A. H., *The Dynamics and Thermodynamics of Compressible Fluid flow - (Vol I and II)*, Ronald Press, New York, 1953.
2. Gopalakrishnan, G. and Prithvi Raj, D., *Treatise on Turbo Machines,* Scitech Publications, Chennai, 2002.
3. Dixon, S. L., *Fluid Mechanics and Thermodynamics of Turbo Machinery*, Pergomen Publications, 1998.

SUPPLY CHAIN MANAGEMENT	
Course Code:23MEPE12	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

- To understand how Logistics, Supply Chain, Operations, Channels of Distribution fit in to various types of Business viz., Manufacturing, Service and Project
- To understand how Warehouse Management and, other functions in Logistics fits into Logistics & Supply Chain Management.
- To understand how Managers, take decisions – strategic, tactical and operations - and how they are taken in Warehouse Management functional area.
- To Understand how models and activities of Supply Chain works.

COURSE LEARNING OUTCOMES (CLO)

After completion ofcourse, students would be able to:

- Identify and Analyze Business Models, Business Strategies and, corresponding Competitive Advantage.
- Formulate and implement Warehouse Best Practices and Strategies
- Plan Warehouse and Logistics operations for optimum utilization of resources
- Understand the various models and activities of SCM

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓		
CO 03		✓	✓	
CO 04				✓

COURSE CONTENTS

Unit-I Introduction of Supply Chain

Basic concepts of Supply Chain Management (definitions and key issues), decisions phases in a supply chain, push and pull views of supply chain, Bull-Whip effect, supply chain strategies.

Unit-II: Driver of Supply Chain

Drivers of Supply Chain performance and their associated Metrics, Supply Chain decision making framework, Network design factors, facility location and capacity allocation models, Distribution Network Design.

Unit- III: Logistics and warehouse in Supply Chain

Mission of Logistics, Logistical Activities, Integrated Logistics, Operating Objectives of Logistics, Logistical Performance Cycles, Structure of Marketing Channels, Marketing Channel Relationships, Economics of Distribution. Product Data Management - Warehouse management system MRP- I, MRP - II, ERP

Unit-IV: Transportation

Transportation Infrastructure: Transportation Functionality and Principles, Modal Characteristics, Modal Classification, Transportation Formats, Suppliers of Transportation Services. Transportation Management: Basic Transport Economics and Pricing, Transport Documentation

Unit-V: Role of Information Technology in supply chain

Information: Information Functionality and Principles, Information Architecture, Applications of New Information Technologies, Case studies.

TEXT BOOKS

1. Sunil Chopra, Peter Meindl and D V Kalra, “Supply Chain Management” Pearson Education.

2. Shari, P. B. and Lassen, T. S., Managing the global supply chain , Viva books, New Delhi, 2000.

3. Ayers, J. B., Hand book of supply chain management, The St. Lencie press, 2000.

REFERENCE BOOKS

1. Nicolas, J. N., Competitive manufacturing management–continuous improvement, Leanproduction, customer focused quality, McGrawHill, New York, 1998.

2. Steudel, H. J. and Desruelle, P., Manufacturing in the nineteen–How to become a mean, leanand world class competitor, Van No strand Reinhold, New York, 1992.

PROGRAMMABLE LOGIC CONTROL

Course Code:23MEPE13	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Describe the purpose of each of the major PLC components
2. Identify types of signals used by PLC and discuss how they are handled

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1. Students will be able to describe typical components of a Programmable Logic Controller.
2. Students will be able to explain the basic concepts of a Programmable Logic Controller
3. Students will be able to state basic PLC terminology and their meanings.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	✓

Unit I

Introduction of PLC, Parts of PLC, Principles of operation, PLC sizes, PLC. Hardware components: I/O section, Analog I/O section, Analog I/O modules, digital I/O modules

Unit II

CPU

Processor memory module, Programming devices, Diagnostics of PLCs with Computers, PLC programming: Simple instructions Programming, EXAMINE ON and EXAMINE OFF instructions

Unit III

Electromagnetic control relays, Motor starters, Manually operated switches, Mechanically operated and Proximity switches, Output control devices, Latching relays, PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram, Timer instructions, ON DELAY timer and OFF DELAY timer, counter instructions, Up/Down counters. Timer and Counter applications program, control instructions, Data manipulating instructions, math instructions

Unit IV

Applications of PLC: Simple materials handling applications, Automatic control of warehouse, door, Automatic lubricating oil supplier, Conveyor belt motor control, Automatic car, washing machine, Bottle label detection, Process control application, PID control of continuous processes, Networking of PLCs

Unit V

Controlling a robot with a PLC, PLC data move, jump functions, SKIP and MCR function, PLC arithmetic, number comparison, PLC Installation, troubleshooting and maintains.

Text Book

1. F D. Petruzella, Programmable Logic Controllers, McGraw- Hills Publications, 4 th edition, 2010.

2. Siemens, PLC Handbook.

References Book

1. W I. Fletcher, An Engineering Approach to Digital Design", Prentice Hall of India Publishers, New Delhi, 3 rd edition, 1999.

2. C H. Roth, Fundamentals of Logic Design,, Jaico Publishing house, 4 th Edition, 1999.

3. Reis & Reis, Programmable Logic Controllers, PHI Learning Publications, 5th edition, 2002.

Micro and Nano Manufacturing

Micro and Nano Manufacturing	
Course Code: 23MEPE14	
Credits: 3	
L T P : 0 0 3	
Prerequisite: Manufacturing Technology	

COURSE OBJECTIVES (CO)

- To acquaint students with the principles and objectives of nano and micro machining
- To familiarize students with the mechanical micromachining and Meso-micromachining
- To acquaint students with the process of mechanical nanomachining
- To make students understand the concepts of unconventional micro-machining techniques
- To familiarize students with laws of micro- and nano-manufacturing.

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to demonstrate:

- The understanding of nano and micro fabrication
- The principles of micro and meso-micromachining
- The process of mechanical nanomachining.
- The understanding of unconventional micromachining
- The manufacturing process of micro and nano manufacturing

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					
CO5					

COURSE CONTENTS

Unit-I Principles of Micro- and Nano-fabrication:

- Introduction- Microfabrication of MEMS and Semiconductor Devices- Nanofabrication of Semiconductor Devices- Material Removal Rates- Pattern Transfer

Unit –II: Mechanical Micromachining and Meso-micromachining

- Mechanical Micromachining- Introduction- Microfluidic Systems- Theory of Micromachining- Experimental Micromachining- Micromachining Tool Design- High-Speed Air Turbine Spindles- Mechanical Design of Rotors- Future developments.

- Meso-micromachining- Introduction- Size Effects in Micromachining- Mechanism for Large Plastic Flow- Inhomogeneous Micro-strains- Origins of the Size Effect- Meso-machining Processes

Unit –III- Mechanical Nanomachining:

- Diamond Nano-grinding- Introduction- Piezoelectric Nano-grinding- Stress Analysis in Nanogrinding Grains- Fracture Dominated Wear Model- Nanogrinding- Porous Nanogrinding Tools- Laser Dressing of Tools- Future Directions
- Nanomachining- Introduction- Nanometric machining- Theoretical Basis of Nanomachining- Implementation- Conclusions- Problems

Unit –IV- Unconventional micro-machining techniques:

- Micro-fabrication Using X-ray Lithography- Introduction- X- ray Lithography- Synchrotron Radiation- Microfabrication Process- Methods of Resist Application- Exposure- Problems
- Micromachining Using Water Droplets- Introduction- Theory of Pulsed Liquid Impact- Impact by Water Drops- Modeling Machining Thresholds- Comparative Results-Material Removal Rates- Design of Water-Based Tools- Analysis of Space Frame-Mode Shapes of Tetrahedral Structure- Conclusions- Problems

Unit - V - Micro-and Nanomanufacturing:

- Introduction – Micromanufacturing- Nanomanufacturing- Commercialization Issues of Micro and Nanotechnologies- Future Developments- Problems

TEXT BOOKS

1. Micro and Nanomanufacturing, M.J. Jackson, Springer

REFERENCE BOOKS

1. Laser Interference Lithography for Micro- And Nano-Fabrication by Ainara Rodriguez and Santiago M Olaizola
2. Micro and Nanofabrication Using Self-Assembled Biological Nanostructures (Micro and Nano Technologies) by Jaime Castillo-León and Winnie Svendsen
3. The Physics of Micro/Nano-Fabrication by Brodie
4. Micro-Nanofabrication: Technologies and Applications by Zheng Cui
5. Electrochemical Micromachining for Nanofabrication, MEMS and Nanotechnology (Micro and Nano Technologies) by Bijoy Bhattacharyya
6. Bio fabrication: Micro- and Nano-fabrication, Printing, Patterning and Assemblies (Micro and Nano Technologies) by Gabor Forgacs and Wei Sun
7. Novel Optical Technologies for Nanofabrication (Nanostructure Science and Technology) by Qian Liu and Xuanming Duan
8. Vistas in Nanofabrication by Faiz Rahma
9. Micro/Nano Manufacturing by Hans Nørgaard Hansen and Guido Tosello , Eds.

TQM AND RELIABILITY ENGINEERING	
Course Code: 23MEPE15	
Credits: 3	
L T P: 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To understand the TQM Principal and their basic tools.
2. To understand the concepts of Reliability.
3. To understand the concepts of Maintainability.
4. To understand the Human involvement to improve the quality.

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion ofcourse, students would be able to:

1. Meaning of TQM and Theories about TQM
2. Planning and manufacturing for quality its tools and techniques
3. Human involvement to improve quality and the development and transformation due to such involvement.
4. About failure models, component reliability & system reliability & maintainability concepts like MTTR, MDT etc.

About mean down time, maintainability of systems & condition monitoring.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	?	?		
CO 02				?
CO 03				?
CO 04			?	

UNIT-I: TQM PRINCIPLES & BASIC TOOL

Customer Satisfaction – Types of customers, customer supplier chain, Customer perception of quality customer feedback - Customer complaints - Customer retention - Service quality.

Employee involvement – Employee motivation - Maslow 's hierarchy of needs - Herzberg theory - Empowerment and team work.

Basic Tools: Introduction to seven basic tools–Check sheets, histograms - Control charts, Pareto diagram -Cause and effect diagram – Stratification - Scatter diagrams.

UNIT-II: NEW SEVEN MANAGEMENT TOOLS & ADVANCED TOOLS:

Affinity diagram - Relations diagram - Tree diagram - Matrix diagram - Matrix data analysis diagram - Process decision program chart - Arrow diagram.

UNIT-III: ADVANCED QC TOOLS

Advanced QC tools like QFD - Root cause analysis - Taguchi method - Mistake proofing (poka-yoke) - Failure mode and effects analysis (FMEAs), failure mode and effects criticality analysis (FMECAs) and Fault tree analysis (FTAs) etc. - Quality Management Systems.

UNIT-IV: RELIABILITY

Definition - Probabilistic nature of failures - Mean failure rate - Meantime between failures - Hazard rate - Hazard models, Weibull model - System reliability improvement – Redundancy – Series - Parallel and Mixed configurations.

UNIT-V: MAINTAINABILITY

Introduction - Choice of maintenance strategy - Mean time- to repair (MTTR) - Factors contributing to Mean Down Time (MDT) - Fault diagnosis, and routine testing for unrevealed faults - Factors contributing to Mean Maintenance Time - (MMT) on condition maintenance - Periodic condition monitoring - Continuous condition monitoring - Economics of maintenance.

Text Book

1. Joel E. Rose, *Total Quality Management*, 2nd Edition, Kogan Page Ltd., USA 1993.
2. Srinath, L. S., *Reliability Engineering*, Affiliated East West Press, New Delhi 1995.

Reference Book and other materials

1. Balagurusamy, E., *Reliability Engineering* Tata McGraw Hill publishing Co., New Delhi, 1984.
2. Greg Bound, et.al, *Beyond Total Quality Management towards the emerging paradigm,* McGraw Hill Inc., 1994.

Zeiri, *Total Quality Management for Engineers,* Wood Head Publishers, 1991.

COMPUTER INTEGRATED MANUFACTURING	
Course Code: 23ME16	
Credits: 3	
L T P: 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

The students will be able to

1. To understand the operations and programming of NC, CNC and DNC machines.
2. To understand the concepts of reverse engineering, computer-aided process planning and unmanned manufacturing.
3. To understand the reverse engineering.
4. To familiar with computer aided process planning for fabrication process.

COURSE LEARNING OUTCOMES (CLO)

After completion ofcourse, students would be able to:

1. Describe scope of C.I.M. in manufacturing technology.
2. Describe scope of group technology in manufacturing industry.
3. Write program for manufacturing component.
4. Prepare CAPP (Computer Aided Process Planning) for fabrication process equipment.
5. Describe concept of reverse engineering.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04	CLO 05
CO 01	⍰	⍰	⍰		
CO 02				⍰	
CO 03					⍰
CO 04			⍰		

UNIT-I

NC/CNC/DNC terminology, Operations of NC/CNC machine tools. Control cycles in CNC machine tools and how do these reduce operator's activities, Central Processing Unit (CPU) ,Input Devices , Storage Devices , System Configuration, Feasible report to introduce CAM technology for the first time in the industry , advantages &limitations of using CNC technology.

UNIT-II

Parameters for adaptation of CAM technology, Advantages and disadvantages of CAM, Part programming, Manual & CAP, APT& its statements/programming with suitable examples to machine the components on CNC lathe, CNC milling machine, CNC jig boring machine, etc, Parallel programming& its advantages, Post etc

UNIT-III

Canned cycles, linear/circular, parabolic interpolation, online/offline programming, unidirectional, bidirectional approach, point to point and continuous control, Buffer storage, adaptive control, Nesting, opti part, opti-route, precision sheet metal processing, CNC turret punch press, CNC press brake & its programming to machine the sheet metal components, Auto indexing, safety aspects in CNC machine tools. Tool length/ cutter compensation, Computer optimized manufacturing, etc

UNIT-IV

CAPP, Types of CAPP, Group technology, Merit/ Demerits, Database management in the development of CAPP, CAD-CAM integration, Essential elements of CAPP, Future trends in CAPP, Importance of CAPP in CAM/CIM, etc. Introduction to Robots, its types, Laws of robotics, Symbolic modelling of robots, Robotic sensors, Configurations of robot, Applications of Robots in engineering industries

UNIT-V

Basic concepts of CIM, Evolution of CIM, Unmanned manufacturing, Elements of CIM, CIM implementation, CIM hardware and CIM software. Product development through CIM, Sequential engineering, Concurrent engineering, Comparison of sequential and concurrent engineering, implementation of concurrent engineering, concurrent engineering and information technology, Characteristics of concurrent engineering.

Text Book

1. M. Thomas Crandell, *CNC Machining and Programming an Introduction,* Industrial Press Inc., New York, 2002.
2. P. Groover Mikell, *Automation, Production Systems, and computer Integrated manufacturing,* Prentice Hall of India, New Delhi, 2003.

Reference Book and other materials

1. K. Yoram, Ben and U. Joseph, *Numerical Control of Machine Tools,* Khanna Publishers, New Delhi, 2005.
2. Mikell P. Groover, and Emory W. Zimmers, *Computer aided design andmanufacturing*, Prentice Hall of India, New Delhi, 2003.
3. P. Radhakrishnan, *Computer Numerical Control Machines,* New Central Book Agency Pvt. Ltd., Kolkata 2004 .
4. HMT Limited, *Mechatronics*, Tata McGraw Hill, New Delhi, 1998.
5. P.N Rao, *CAD/CAM*, Tata McGraw Hill, New Delhi, 2005.

COMPUTATIONAL FLUID DYNAMICS	
Course Code:23MEPE17	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To familiarize students with basic concepts of partial differential equations, theirapplications to CFD problems
- To familiarize students with fundamentals of discretization.
- To familiarize students with the solving procedure of heat transfer and fluid flowproblems using FDM and FVM.
- To familiarize students with the problems and limitations and errors involved insolution to CFD problems.

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). Aftercompletion of course, students would be able to:

- Understand basic concepts of partial differential equations
- Understand fundamentals of discretization and application to CFD problems
- Understand the application of FDM and FVM
- Understand the limitations and errors involved in solution to CFD problems

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNINGOUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

COURSE CONTENTS

UNIT-I

INTRODUCTION: Introduction to C.F.D., Governing Differential Equations of Fluid Dynamics: Continuity Equation, Navier Stokes Equation, energy equation, Classification of Partial Differential Equations, Boundary and Initial Conditions, Approximate Solutions to Differential Equations

UNIT-II

Governing Equations

Classification of quasi linear partial differential equation, General method of determining the Classification of partial differential equation, hyperbolic, parabolic, elliptic equations.

Fundamentals of Discretization: Finite Element Method, Finite Difference and Finite Volume Method, Consistency, Stability and Convergence.

UNIT-III

Finite Volume Discretization of 2-D unsteady State Diffusion type Problems, Solution of Systems of Linear Algebraic Equations: Elimination Methods, Iterative Methods

UNIT-IV

Heat conduction problem: Solution of One-dimensional heat conduction through a fin, solution of two-dimensional steady state and transient heat conduction problems, heat conduction problems in cylindrical coordinates: axisymmetric and non-axisymmetric problems.

UNIT- V

Fluid flow problem: Viscous incompressible flow, solution of the Couette flow problem by F.D.M., calculation of the flow field using stream function – vorticity method, numerical algorithms for solving complete Navier-Stokes equation – MAC method; SIMPLE method.

Textbook(s)

1.Versteeg, H.K., and Malalasekara, W, “An Introduction to Computational Fluid Dynamics”, The Finite Volume Method, 2007.

2.Moukalled, F., Mangani, L., &Darwish, M. “The finite volume method in computational fluid dynamics. An Advanced Introduction with OpenFOAM and Matlab”, 2016.

Reference(s)

1.Anderson, J. D., & Wendt, J., “Computational fluid dynamics” (Vol. 206). New York: McGraw-Hill, 1995.

2.Niyogi, Chakraborty and Laha, Introduction to Computational Fluid Dynamics, Pearson Education.

Automobile Engineering	
Course Code: 23MEPE18	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To know the layout and arrangement of principal parts of an automobile.
2. To understand the working of transmission and brake systems.
3. To comprehend the operation and working of steering and suspension systems.
4. To know the Injection system and its advancements.
5. To know the automobile emissions and its effects on the environment.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1. Identify the different parts of an automobile and its working.
2. Understand the working of transmission and braking systems.
3. Understand the working of steering and suspension systems and their applications.
4. Selection and applications of various types of fuels and injection systems.
5. Analyze the cause of automobile emissions, their effects on the environment, and methods to reduce the emissions.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)				
	CLO 1	CLO 2	CLO3	CLO4	CLO5
CO 1	√				
CO 2		√			
CO 3			√		
CO4				√	
CO5					√

Course Content

Unit-I

Introduction:

ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives' merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car. COOLING AND LUBRICATION: Cooling requirements, Types of cooling-

Thermosiphon system, Forced circulation water cooling system, Water pump, Radiator, Significance of lubrication, Splash and Forced feed system.

Unit-II

TRANSMISSION SYSTEMS: Clutch-types and construction, gearboxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive, and Torque Tube Drive. BRAKES: Types of brakes, mechanical compressed air, vacuum, and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of the antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock, & Numerical.

Unit-III

STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system. IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

Unit- IV

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag. FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, Alternative fuels, Normal and abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburetors, C.D.& C.C. carburetors, Multi-point, and Single point fuel injection systems, fuel transfer pumps, fuel filters, fuel injection pumps, and injectors. Electronic Injection system, Common Rail Direct Injection System.

Unit- V

AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter. EMISSION STANDARDS: Euro I, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act.

Text Books

1. Automobile engineering Vol I and II Kirpal Singh Standard Publishers 12th Edition 2011.
2. Automotive Mechanics S. Srinivasan Tata McGraw Hill 2003 2nd Edition.

Reference Books

1. Automotive Mechanics William H Crouse & Donald L Anglin Tata McGraw Hill Publishing Company Ltd 10th Edition 2007
2. Automotive Mechanics: Principles and Practices, Joseph Heitner D Van Nostrand Company, Inc.
3. Automobile Engineering R. B. Gupta Satya Prakashan 4thedition 1984.
4. Fundamentals of Automobile Engineering K.K.Ramalingam Scitech Publications (India) Pvt. Ltd

COMPOSITE MATERIALS	
Course Code: 23MEPE19	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Terms associated with composite materials
2. Basics of composite manufacturing
3. Different kinds of composite materials and their testing standards
4. Mechanics of damage in composite materials.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course, student should be able

1. To understand the terms associated with composite materials
2. To differentiate between different types of composite materials
3. To manufacture composite materials by VARTM process
4. To understand testing standards of composite materials
5. To apply failure theories to composite materials.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO 1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	✓

COURSE CONTENTS

Unit-I Introduction

Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials,

Types of fibres, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres.

Unit-II Various types of composites

Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

Unit-III Fabrication methods

Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

Unit-IV Testing of Composites

Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing.

Unit-V Mechanics

Failure Theories and Strength of Unidirectional Lamina, Design consideration, analysis of laminates after initial failure, interlaminar stresses, fracture mechanics, experimental characterization, Micromechanics, Factors influencing strength and stiffness failure modes,

TEXT BOOK

1. Mechanics of composite materials and structures, M. Mukhopadhyay. Universities Press, 2012
2. FIBER REINFORCED COMPOSITES: Materials, Manufacturing, and Design, P.K. Mallick, CRC Press, 3rd Edition 2007,
3. Mechanics of Composite Materials, R.M. Jones, Taylor and Francis, 2nd Edition, 1999

REFERENCE BOOK

1. Materials characterization, Vol. 10, ASM hand book
2. Mechanical Metallurgy by G. Dieter Mc-Graw Hill
3. Thermal Analysis of Materials by R.F. Speyer, Marcel Decker
4. Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall India

FINITE ELEMENT METHODS	
Course Code:23MEPE20	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

- To Understand the fundamental of Basics of Finite Element analysis
- To understand various method used for solving FEM
- To understand different equation used to develop FEM model.
- To Understand the characteristics of FEM for the section like trusses, bars & beams.

COURSE LEARNING OUTCOMES (CLO)

After completion ofcourse, students would be able to:

- Understand the concepts of Basics of Finite Element analysis
- Understand different methods for solving FEM problems
- Develop element characteristic equation and generation of global equation.
- Able to apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, and dynamic problems and solve them displacements, stress and strains induced.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓		
CO 03			✓	
CO 04				✓

COURSE CONTENTS

UNIT I- INTRODUCTION TO FINITE ELEMENT ANALYSIS

Basics of FEA, historical comments, FEM applications. General field problems in engineering-Modeling – Discrete and continuous models – Characteristics - Difficulties involved in solution - The relevance and place of FEM. Boundary and initial value problems concepts.

UNIT II- CALCULUS OF VARIATIONS

Variational formulation in FEM, weighted residual methods – Galerkin method, sub domain method, method of least square and collocation method - The Ritz Method - Simple numerical problems.

UNIT III- STATIC ANALYSIS

General procedure of FEM, skeletal and continuum structures, descritization of domain, basic types of elements - truss, beam, triangular, quadrilateral and brick elements - shape functions, Rayleigh-Ritz method, formulation of element stiffness matrices - Isoparametric elements.

UNIT IV- FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS

One dimensional second order equations -Generalized coordinate approach, derivation of element equation - Assembly of element equation - Imposition of boundary conditions - Solution of equation - Cholesky method - Extension of the method to fourth order equation - Time dependent problems from heat transfer and solid mechanics - Heat transfer through simple fins, composite wall, bending of beams.

UNIT IV- FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS

Global and natural coordinates - second order equations involving scalar valued function - model equation - Variational formulation - Finite element formulation through generalised coordinate approach – Convergence criteria for chosen models - Interpolation functions - Element matrices - Problems on bending of plates and heat transfer in two dimensions.

INTRODUCTION TO ADVANCED TOPICS

(Only preliminaries to be covered. Not included for examination) Three dimensional problems, use of software packages.

TEXT BOOKS

1. Chandrupatla and Belegundu, *Finite Elements in Engineering*, Prentice Hall of India Pvt. Ltd., 1997.
2. Reddy, J. N., *An Introduction to Finite Element Method,* McGraw Hill International Editions, 1993.

REFERENCE BOOKS

1. Rao, S. S., *The Finite Element Methods in Engineering*, Pregamon Press, 1989.
2. Krishnamoorthy, C. S., *Finite Element Analysis -Theory and Programming*, Tata McGraw Hill publishing Co., 1987.
3. Zienkiewicz, O. C., *The Finite Element Method in Engg. Science*, McGraw Hill, London, 1977.

MECHANICAL VIBRATION	
Course Code: 23MEPE21	
Credits : 3	
L T P : 3 0 0	
Prerequisite : NIL	

COURSE OBJECTIVES (COs)

Students will be able to

1. Know the concepts of vibration and noise.
2. Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.
3. Analyze the Single Degree, Two Degree and Multi degree of Freedom Systems.
4. Understand and diagnose the case studies on the field of Vibration.
5. Identify the sources of noises and the ways to control it.

COURSE LEARNING OUTCOMES (CLOs)

Upon successful completion of the course the students will be able to

1. Construct the equations of motion for free-body diagrams
2. Compute the natural frequency for free and forced vibration of a single degree of freedom under damped or un-damped system
3. Apply vibration absorbers and isolators for minimizing vibration in systems with two degree of freedom.
4. Identify and estimate the case studies on the field of Vibration.
5. Demonstrate sources of noises and the ways to control it.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-I: SIMPLIFICATION OF VIBRATION PROBLEMS TO ONE DEGREE OF FREEEDOM

Basic equation of motion for various vibration problems – Torsional, Free damped and Forced vibration problems, critical speed, nature of exciting forces, vibration isolation, vibration instruments.

Unit-II: TWO AND MULTI-DEGREE OF FREEDOM SYSTEMS

Two degree – Formulation of solution - Coupling between rotating and translation - Applications. Multi degree – Governing equation for close coupled systems - Lateral vibration, Geared systems - Effect of gyroscopic acceleration.

Unit-III: SOLUTION OF VIBRATION PROBLEMS

Approximate methods (or) Numerical methods – Holzer‘s method, Myklestadt‘s method, Sturn sequence. Energy methods – Rayleigh‘s Approach – Close coupled systems. For coupled systems – Dunkerley‘s method, Rayleigh Ritz method.

Unit-IV: DIAGNOSTICS AND FIELD MEASUREMENT

Diagnostic tools - Condition monitoring in real time - Balancing of rotors - Field measurements on various compressors, fans, machine foundation.

Unit V: MACHINERY NOISE AND CONTROL

Basics of noise - Introduction, amplitude, frequency, wavelength and sound - Pressure level, noise dose level - Measurement and analysis of noise. Methods for control of noise - Mechanical noise - Predictive analysis, Sound in enclosures - Sound energy absorption - Sound transmission through barriers.

TEXT BOOK:

1. Ramamurti, V., *Mechanical Vibration Practice with Basic Theory*, 1st edition, Narosa Publishing House, Chennai, 2000.
2. Kewel Pujara., *Vibration and noise for engineers*, Dhanpat rai & Sons, 1992.
3. Singh, V. P., *Mechanical Vibrations*, Fourth edition, Dhanpat Rai & Co., 2014.

REFERENCE BOOK

1. Rao, J. S. and Gupta, K., *Introductory course on theory and practice of mechanical vibrations,* Wiley Eastern, New Delhi, 1984.
2. Rao, S. S., *Mechanical vibrations*, 3rd Edition, Addison Wesley publishing company, New York, 1995.
3. Thomson, W. T., *Theory of Vibration and its Applications*, Prentice Hall, New Delhi, 1982.
4. Meirovitch, L., *Elements of Vibration Analysis*, Mc Graw-Hill Book Co., New York, 1986.
5. Keith Mobley, R., *Vibration Fundamentals*, Plant Engineering Maintenance Series, Elsevier, 2007.

LATEST TRENDS IN MECHANICAL ENGINEERING	
Course Code: 23MEPE22	
Credits: 3	
L T P : 0 0 3	
Prerequisite: Strength of Materials	

COURSE OBJECTIVES (CO)

- To know and understand the use of IOT in the field of Manufacturing, agriculture and energy management
- To know about the recent developments in thermos-fluid
- To know about the recent advancement in industrial automation

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to demonstrate:

- Demonstrate the various uses of IOT in different sectors.
- Develop new concepts in recent development in nano fluid and nano fluid energy conversion
- Describe block chain for industrial application.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES		
	CLO1	CLO2	CLO3
CO1			
CO2			
CO3			

COURSE CONTENTS

Unit-I: Introduction to Internet Of Things (IOT) : - Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine to Machine communications, Connected Vehicles, Industrial IoT.

Unit II Rapid Prototyping: - Introduction to Rapid Manufacturing, Customization and Mass Customization, Classification of Rapid Manufacturing Processes (Additive/Subtractive/Formative), Part Deposition Orientation and its Importance, Direct Slicing and STEP related Details Data Format (STEP) and its details related non layered manufacturing processes,

Unit –III: Recent Developments in Thermo-Fluid and Design Fluid:-Introduction to micro fluids, lubrication theory, thin film dynamics, introduction to Nano fluids and Nano fluidic energy conversion.

Unit –IV: Hyperloop Transportation:- Intoduction to Capsule, Geometry, Interior, Compressor, Suspension, Onboard Power, Propulsion. Tube- Geometry,construction, pylons and tunnels, Propulsion- Rotor, Stator, Energy Storage Components, Proulsion for Passenger plus Vehicle system. Safety and Reliablity- Onboard passenger Emergency, Power outage, Capsule Depressurization, Capsule Stranded in Tube, Structural Integrity of tube in Jeopardy, Earthquakes, Reliablity. Economic Considerations.

Unit V Block Chain for Industrial Application :-Re-shaping supply chain management through a public, direct peer-to-peer (P2P)manufacturing ecosystem, Incentivizing Change in Supply Chain Management, Smart Manufacturing Blockchain, Smart Contracts for Transparent Procurement Processing, Smart Business Model for Decentralized Supply Chain Management, Manufacturing Utility Token: Incentivizing Blockchain Buy-in, Risk Factors.

TEXT BOOKS

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)

2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)

REFERENCE BOOKS

1. NPTEL Lecture Series and Coursera

2. Decentralized Manufacturing: Smart MFG Tech LTD, V16 - February 15, 2018

3. Hyperloop Alpha: Musk, Elon (August 12, 2013). "Hyperloop Alpha" (PDF). SpaceX. Retrieved August 13, 2013.

2. SPECIALIZATION IN ELECTRIC AND HYBRID VEHICLE

PROFESSIONAL ELECTIVE COURSES

Alternative Sources of Energy And System	
Course Code:23MEPE01	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To familiarize the students with the concept of Biomass
2. To familiarize the students with the concept of Solar Energy
3. To familiarize the students with the concept of Wind Energy OTEC
4. To familiarize the students with the concept of Fuel cells
5. To familiarize the students with the concept of MHD systems.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1.To analyze the various renewable energy sources like wind, solar,

2. To analyze the various biomass, Ocean energy, Fuel cells and MHD systems.

3. Exposure on biomass gasification and combustion, Theory of flat plate collectors, photo voltaic, thermal applications and limitations of solar energy are also provided.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	
CO 03		✓	
CO 04			✓
CO 05			✓

COURSE CONTENTS

UNIT 1: BIOMASS

Biomass, sources of biomass - Fermentation, pyrolysis, gasification and combustion - Biogas, calorific value - Power generation, biogas plant design and operation. Thermo-chemical conversion of biomass – Energy balance, conversion to solid, liquid, and gaseous fuel.

UNIT II: SOLAR ENERGY

Solar radiation and its measurements. Flat plate collectors – Photovoltaic and thermal applications – Limitation of solar energy – Theory of flat plate collectors – Solar water heating, solar drying, solar stills, solar cooling and refrigeration.

UNIT III: WIND ENERGY

Basic principle of Wind energy conversion – Wind data and Energy Estimation – Site selection considerations – components of WECS – Advantages and disadvantages of WECS – Design consideration of horizontal axis Machines – Analysis of aerodynamic forces acting on the blade – Performance of wind Machines

UNIT IV: OCEAN ENERGY

Ocean Thermal Energy Conversion - Wave and tidal energy - Availability, geographical distribution - Power generation using OTEC - Scope and economics - Geothermal energy, availability.

UNIT V: ELECTROCHEMICAL ENERGY SOURCES - BATTERIES

Cell and batteries – types of batteries, Primary batteries – Lechalanche cell (dry cell), Lithium cell, Secondary batteries(Accumulators) – Lead acid battery, Alkaline battery Ni-Cd battery, , Lithium-ion battery, Fuel cells- H2 – O2 fuel cell & Methanol – Oxygen fuel cell, Photovoltaic Cell- Solar Cell.

TEXT BOOKS

3. Rai, G. D., Non-Conventional Energy Sources, Khanna Publishers, 4th edition, New Delhi, 2005.
4. Wakil, M. M. EL., Power Plant Technology, McGraw Hill Book Company, New York, 1984.

REFERENCE BOOKS

2. Soreyson, B., Renewable Energy, Academic Press, 1989.

Twidell, J. W. and Weir, A. D., Renewable Energy Resources, ELBS Publication, 1986.

INTRODUCTION TO SENSORS, ACTUATORS & IOT	
Course Code:23MEPE02	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To make students know the IoT eco system.
2. To provide an understanding of the technologies and the standards relating to the Internet of Things.
3. To develop skills on IoT technical planning.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

5. To understand the basics of Networking and Security.
6. To understand predecessor of IoT technology and emergence of Internet of Things.
7. To understand architecture for Internet of Things.
8. To recognize various devices, sensors, actuators, and various processing paradigms for IoT

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓

Course Content

UNIT - I

Basics of Networking & Basics of Network Security: Network Types, Layered Network Models, Addressing, Internet of Things TCP/ IP Transport layer, Security, Network Confidentiality, Message Integrity and Authenticity, Digital signatures, Key Management, Internet Security & Firewall.

UNIT - II

Predecessors of IoT & Emergence of IoT–Introduction, Wireless Sensor Networks, Machine-to-Machine Communications, Cyber Physical Systems, Architectural components of CPS, IoT versus M2M, IoT versus CPS, IoT versus WoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components, Addressing Strategies in IoT.

UNIT - III

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing

UNIT - IV

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations,

UNIT V Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing

Topologies, IoT Device Design and Selection Considerations, Processing Off loading, Off load location, Off load decision making, Off loading considerations.

Text Books:

1. Internet of Things, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, John Wiley & Sons.
2. Sudip Mishra, Anandarup Mukherjee, Arijit Roy: Introduction to IOT, Cambridge University Press.

Reference Books:

1. Bassi, Alessandro, etal, “Enablingthingstotalk”,Springer-VerlagBerlin-2016
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
3. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/ Maker Media Publishers.

Mechanical Behavior and Testing of Materials	
Course Code: 23MEPE03	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To familiarize students with the fundamental concepts of mechanical behavior of materials,
- To familiarize students with the fundamental concepts various mechanical testing
- To familiarize students with the fundamental concepts practices and to apply them to design the materials for various load-bearing structural engineering applications.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

- Understand the basics of elastic and plastic deformation
- Analyse the plasticity, dislocation and strengthening mechanisms
- Understand and analyse the tensile behaviour of materials and correlating with microstructures
- Understand fatigue and creep behaviour and evaluate & design materials for better creep and fatigue resistance

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	COL1	COL 2	COL3	COL 4
CO 1	√			
CO 2		√		√
CO 3			√	

COURSE CONTENTS

Unit-I

Elastic and plastic deformation, stress-strain relationship; plastic deformation of metallic materials, Mohr's circle, Yielding criterion- Von Misses, and maximum-shear-stress/Tresca yielding criterion, failure criteria under combined stresses

Unit-II

Elements of theory of plasticity, dislocation theory, properties of dislocation, stress fields around dislocations, elementary dislocation interactions; application of dislocation theory to work hardening and strengthening mechanisms.

Unit-III

Engineering stress-strain curve, true stress-strain curve, instability in tension, stress distribution at the neck, , testing machines, Tensile properties of important materials.

Unit-IV

Introduction, Brinell, Vickers and Rock well hardness tests, Meyer hardness, analysis of indendation by an indenter, relationship between hardness and the flow curve, microhardness tests, hardness conversion; hardness at elevated temperatures. Introduction to torsion, torsional stresses for large plastic strains, types of torsion failures torsion test vs. tension test, hot torsion testing.

Unit-V

Introduction to fatigue testing, practice and evaluation; fatigue crack growth; low cycle, high cycle fatigue; Introduction to creep; stress rupture testing; creep data extrapolation; fatigue-creep interactions; superplasticity.

Text Books

3. Dieter G. E., 'Mechanical Metallurgy', 3 rd Edition, McGraw Hill Publications, 2004
4. Dowling NE, Mechanical Behaviour of Materials, 4th Ed, Pearson, 2013

Reference Books

5. Hull, D., Bacon, D.J., Introduction to Dislocations, 5th Ed., Butterworth-Heinemann, 2011
6. Suryanarayana, AVK., 'Testing of Metallic Materials', BS Publications, 2018

Hydraulic Machine	
Course Code:23MEPE05	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

5. To familiarize with conservation laws and dimensional analysis
6. To familiarize flow through closed conduits and hydraulic machines.
7. To familiarize hydraulic turbine.
8. To familiarize hydraulic pumps .

COURSE LEARNING OUTCOMES (CLO)

6. Student will be able to understand fluid principle
7. Student will be able to understand concept of IMPULSE TURBINE
8. Student will be able to understand concept of reaction turbine
9. Student will be able to understand concept of different type of pump
10.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

Course Content

Unit I

IMPACT OF FREE JETS Impulse – momentum principle, jet impingement - on a stationary flat plate, inclined plate and a hinged plate, at the center of a stationary vane, on a moving flat plate, inclined plate, a moving vane and a series of vanes, Jet striking tangentially at the tip of a stationary vane and moving vane(s), jet propulsion of ships.

Unit II

IMPULSE TURBINES Classification – impulse and reaction turbines, water wheels, component parts, construction, operation and governing mechanism of a Pelton wheel, work done, effective head, available head and efficiency of a Pelton wheel, design aspects, speed ratio, flow ratio, jet ratio, number of jets, number of buckets and working proportions,

Unit III

REACTION TURBINES Component parts, construction and operation of a Francis turbine, Propeller,

Kaplan turbine, differences between the Francis and Kaplan turbines, governing mechanism, work done by the turbine runner, working proportions and design parameters, slow, medium and fast runners, degree of reaction, inward/outward flow reaction turbines, construction and operation of a draft tube - its function and different forms, Introduction to new types of turbine, Deriaz (Diagonal), Bulb, Tubular turbines, Problems.

Unit IV

MODEL SIMILITUDE Performance Characteristics and governing of impulse turbines ,Performance Characteristics and Governing of reaction turbine Unit quantities, specific speed and model relationships for turbines, scale effect, cavitations – its causes, harmful effects and prevention, Thomas cavitation factor, permissible installation height, Problems.

Unit V

PUMPS Centrifugal Pumps: Classification, velocity vector diagrams and work done, Similarity relations and specific speed, net positive suction head, cavitation and maximum suction lift, performance characteristics. Brief introduction to axial flow, mixed flow and submersible pumps,

Reciprocating Pumps: Construction and operational details, discharge coefficient, volumetric efficiency and slip, work and power input, characteristic curves, centrifugal vs reciprocating pumps, brief introduction to screw, gear, vane and radial piston pumps.

Text Books :

1. Hydraulics & Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi

2. Hydraulic Machines – Jagdish Lal, Metropolitan

Reference Books :

1. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers

2. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill 3. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons

Industrial Engineering and Operations Research	
Course Code:23MEPE06	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

5. To understand the concepts of Linear programming technique
6. To understand the applications and use of Assignment, Transportation and Replacement models
7. To familiarise with PERT and CPM technique
8. To familiarise with detailed knowledge of Inventory control and queing theory

COURSE LEARNING OUTCOMES (CLO)

Students completing this course will be able to,

1. Formulate real-world problems as a linear programming model and describe the theoretical workings of the graphical and simplex method
2. Understand different queuing situations and find the optimal solutions using models for different situations
3. Understand variety of problems such as assignment, transportation, travelling salesman etc
4. Understand the concept of Queuing Theory

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

COURSE CONTENTS

UNIT I- LINEAR PROGRAMMING Operations research and decision making - Types of mathematical models and constructing the model - Formulation of linear programming problem - Simplex method (Analytical & Graphical) - Two phase and Big M methods.

UNIT II- ASSIGNMENT AND TRANSPORTATION MODELS Assignment models - Transportation problem – North west corner method – Least cost method – Vogel‘s approximation method – Modi method, Unbalance and degeneracy in transportation model. Replacement theory.

UNIT III- SCHEDULING AND NETWORK ANALYSIS Problem of sequencing – Processing ‗n‘ jobs through two machines and three machines - Processing two jobs through ‗m‘ machines. Network analysis –

PERT and CPM.

UNIT IV - Production Planning and Control

Objectives of PPC- Functions of PPC- Aspects of product development and design- Process Planning, Principles of Standardization, specialization, Simplification-Group Technology- Optimum Batch size, ABC analysis-Value engineering, Traceability, Inventory reconciliation.

UNIT V- QUEING THEORY Queing Theory: Poisson arrivals and exponential service times - Waiting time and idle time cost - Singlechannel, multi channel problem, Monte Carlo technique applied to Queing problems - Poisson arrivals and Service time.

TEXT BOOKS

1. Handy, A. Taha, Operations Research, 5th Edition, Prentice Hall of India, New Delhi, 1995.
2. Philip and Ravindran, “Operational Research ", John Wiley, 1992.

REFERENCE BOOKS

1. Premkumar, Gupta and Hira, Operation Research, S. Chand & Co., New Delhi, 1986.
2. Fredric S. Hilleer and Gerold J. Lieberman, Introduction to Operation Research, 2nd Edition, CBS, 1974.
3. J.K.Sharma, “Operations Research”. 6th Edition, Trinity

FLEXIBLE MANUFACTURING SYSTEMS	
Course Code: 23MEPE07	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

5. To introduce flexible manufacturing concepts.
6. To give exposure to the student to different types of advanced manufacturing processes, automated flow lines.
7. To study about group technology and Flexible manufacturing systems.
8. To study the use computers in the area of manufacturing to reduce manual processing and linking computers to all the manufacturing machines and increase the productivity, reduce the unnecessary costs.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

6. Understand different types of production system.
7. Identify how automation can be used in production systems.
8. Recall basic elements of automation, and automation strategies.
9. Apply group technology, cellular manufacturing concepts.
10. Design of flexible manufacturing cells and systems

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				
CO 2		√			
CO 3			√		
CO 4				√	
CO 5					√

COURSE CONTENTS

Unit-I PRODUCTION SYSTEMS

Types of production: Job Shop, Batch and Mass production, Functions in manufacturing, Organization and information processing in manufacturing, Plant layout, Batch production, Automation in Production system, Production quantity and product variety, Production rate, Production capacity, Utilization, Availability, Manufacturing lead time for all types of production, Work in progress inventory, Scheduling and its problems

Unit-II GROUP TECHNOLOGY

Introduction to GT, Formation of part families, Part classification - Coding system: Optiz, Multi Class and Production flow analysis, Machine cells design: Clustering methods, Modern algorithms, Benefits of GT, System planning, Objective, guide line, system definition and sizing, Human resources: Objective, staffing, supervisor role.

Unit-III FLEXIBLE MANUFACTURING SYSTEMS

Introduction, Evolution, Definition and Need for FMS, Need for Flexibility, Economic Justification of FMS-Application Criteria, Machine tool Selection and Layout, Computer control system, Data files, Reports, Planning the FMS, Sizing of FMS, Quantitative Analysis Methods for FMS, Bottle neck and extended Bottle neck model, Benefits and limitations.

Unit-IV FLEXIBLE MANUFACTURING CELLS

Introduction to manufacturing cell, Cell description and classifications, unattended machining, Component handling and storage system, Cellular versus FMS, System Simulation, Hardware configuration, PLC and Controllers, Communication networks, Lean production and agile manufacturing.

Unit-V FMS SOFTWARE

Introduction to FMS software, General Structure and requirements, Functional descriptions, Operational overview, Computer simulation, FMS installation, Objective, Acceptance testing, Performance goals and Expectations, Continued support.

Text Book

1. William W. Luggen, Flexible Manufacturing Cells and Systems, Prentice Hall, New Jersey, 1991.
2. Mikell P. Groover, Automation Production Systems &Computer Integrated manufacturing, Prentice Hall of India, New Delhi, 2007.

Reference Book

1. David J. Parrish, Flexible Manufacturing, Butterworth-Heinemann, Newton, MA, USA, 1990.
2. Buffa, E. S., Modern Production and Operation Management, New York, 1985.
3. Jha, N.K. " Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991

FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLES TECHNOLOGY	
Course Code: 23MEEV01	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

To understand the concept of electric vehicles.

1. To study about the motors & drives for electric vehicles.
2. To understand the electronics and sensors in electric vehicles.
3. To understand the concept of hybrid vehicles.
4. To study about fuel cell for electric vehicles.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course the student will be able to

1. Describe about working principle of electric vehicles.
2. Explain the construction and working principle of various motors used in electric vehicles.
3. Understand about working principle of electronics and sensor less control in electric vehicles.
4. Describe the different types and working principle of hybrid vehicles

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1				√
CO 2			√	
CO 3		√		
CO 4	√			

COURSE CONTENTS

Unit-I : Introduction to Electric Vehicles

Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life. Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar.

Unit-II Electric Vehicle Motors

Motors (DC, Induction, BLDC) – Types, Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling. Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor, Design.

Unit III Electronics and Sensor-less control in EV

Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self drive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based

Unit-IV Hybrid Vehicles

Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.

Unit-V Fuel Cells for Electric vehicles

Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.

Text Books

1. *Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.*
2. *2. Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell*
3. *Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007*
4. *3. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.*

Reference Books

1. *Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.*
2. *Hybrid Electric Vehicles – Teresa Donateo, Published by ExLi4EvA, 2017.*
3. *Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.*
4. *Hybrid, Electric & Fuel-Cell Vehicles Jack Erjavec, Delmar, Cengage Learning.*
5. *Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.*

Vehicle Dynamics	
Course Code: 23MEEV02	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Kinematics of Machines, Dynamics of Machinery (Mechanical Engineering), Automobile System, Physics (Automobile Engineering)	

COURSE OBJECTIVES (CO)

1. To familiarize students with fundamental of Vehicle Dynamics such as SAE Vehicle axis system, Aerodynamics, Tire Mechanics, Suspensions , & the Steering System.
2. To familiarize students with the working principle of SAE Vehicle axis system, Aerodynamics, Tire Mechanics, Suspensions, & the Steering System.
3. To impart students with the knowledge of design parameters of Vehicle Dynamics.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1. Understand the basic working principles of basic elements of Vehicle Dynamics such as SAE Vehicle axis system, Aerodynamics, Tire Mechanics, Suspensions, & the Steering System.
2. Understanding of Constructional details, comparison of different types of SAE Vehicle axis system, Aerodynamics, Tire Mechanics, Suspensions, & the Steering System

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)	
	CLO 1	CLO 2
CO 1	√	
CO 2	√	√
CO 3		√

Course Content

Unit-I

SAE Vehicle axis system, Forces & moments affecting vehicle, Earth Fixed coordinate system, Dynamic axle loads, Equations of motion, transmission characteristics, vehicle performance, power limited and traction limited acceleration, braking performance, Brake proportioning, braking efficiency.

Unit-II

Aerodynamics: Mechanics of Air Flow around a Vehicle, Pressure Distribution on a Vehicle, Aerodynamic Forces, Drag Components, Aerodynamics Aids

Unit-III

Tire Mechanics: Tire Construction, Size and Load Rating, Terminology and Axis System, Tractive Properties, Cornering Properties, Camber Thrust, Aligning Moment, Combined Braking and Cornering, Conicity and Ply Steer, Slip, Skid, Rolling Resistance, Elastic Band Model for longitudinal slip, Simple model for lateral slip, Combined longitudinal/lateral slip (friction ellipse), Taut string model for lateral slip, Magic Tire Formula.

Unit-IV

Suspensions: Suspension Kinematics, Suspension types, Solid Axles, Independent Suspensions, Anti-Squat and Anti-Pitch Suspension Geometry, Anti-Dive Suspension Geometry, Roll Center Analysis, Suspension Dynamics, Multi-body vibration, Body and Wheel hop modes, Invariant points, Controllable Suspension Elements: Active, Semi-Active. Choice of suspension spring rate, Calculation of effective spring rate, Vehicle suspension in fore and apt directions.

Unit-V

The Steering System: The Steering Linkages, Steering System Forces and Moments, Steering System Models, Steering Geometry, Steady Handling (2 DOF steadystate model), Understeer and Oversteer, Effect of Tire Camber and Vehicle Roll (3 DOF steady-state model), Transient Handling and Directional Stability (2 DOF unsteady model), Effect of Vehicle Roll on Transient Handling (3 DOF unsteady model), Steady-State and Transient Handling of Articulated Vehicles.

Text Books:

1. James E Duffy, “Modern Automotive Technology”, Goodheart-Willcox; Seventh Edition, 2011.
2. 2.Jack Erjavec, “Automotive Techology –A systems approach”, Cengage Learning,2009.

Reference Books:

1. Hans Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012.
2. Thomas D Gillespie, "Fundamentals of Vehicle dynamics", SAE USA 1992.
3. Rajesh Rajamani, Vehicle Dynamics & control, Springer.
4. R.V. Dukkipati, Vehicle dynamics, Narsova Publications.
5. Wong J Y, "Theory of Ground Vehicles", John Wiley & Sons, New York, 1978.
6. Milliken W F and Milliken D L, Race car Vehicle Dynamics, SAE.
7. Garrett T K, Newton K and Steeds W, "Motor Vehicle", Butter Worths & Co., Publishers Ltd., New Delhi, 2001.
8. Heinz Heister, "Vehicle and Engine Technology", SAE Second Edition, 1999.
9. Vittore Cossalter, Motorcycle Dynamics, 2nd Edition, Publisher: LULU.com
10. R N Jazar, Vehicle Dynamics: Theory and Application, Springer.

SIMULATION MODELLING OF MANUFACTURING SYSTEMS	
Course Code: 23MEPE10	
Credits: 3	
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (CO)

• To impart knowledge in the field of modern methods for simulation and modelling of production systems for industrial needs.

• To focus on technological processes and manufacturing systems and applies the principles of discrete simulation for their modeling using software tool.

• To familiarize with discrete event simulation for modelling & simulation of manufacturing systems.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1: Understand the basic concepts and applications of discrete event simulation

2: Analyze the simulation input data

3: Verify and validate simulation models using statistical techniques

4: Analyze and interpret the simulation output results CO5: Build credible simulation models for real-time applications

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			√
CO 2	√	√	√	
CO 3				√

Unit 1

Introduction: Introduction to manufacturing systems – Introduction to simulation – applications – System and System Environment – Types of Simulation, Plant and process simulation - Simulation procedure – Examples of simulation. Probability distributions: Review of basic probability and statistics – Probability distributions – Random number generators – Testing of Random numbers.

Unit 2

Analysis of Simulation input data: Data Collection – Statistical analysis of numerical data – Tests for Independence and Identically distributed data - Distribution fitting – selecting a distribution in the absence of data – Modelling discrete probabilities – Demonstration of input modelling using Arena

Unit 3

Simulation package. Model Building of Discrete systems: Modelling Paradigms - Modelling of Structural elements and Operational elements – Modelling issues – Model Verification and Validation.

Unit 4

Applications of Simulation in Manufacturing – Manufacturing Modelling Techniques – Modelling Material Handling system – Model building exercises using Arena - Case study. Simulation output analysis:

Unit 5

Design of Simulation Experiments: Determination of warm up period, Run length, Number of replications - Statistical analysis of simulation output – Terminating and Non-Terminating Simulations – Comparing alternative system designs – Variance reduction Techniques – Simulation Optimization.

Text Books

3. Law A. W. and Kelton D. W. - ‘Simulation Modeling and Analysis’ - McGraw Hill - 2010 - 5th Edition.
4. Kelton D. W., Sadowski R. P. and Sasowski D. A. - ‘Simulation with ARENA’ - McGraw Hill – 2009.

Reference Books

3. Banks J., Carson J. S., Nelson B. L. and Nicol D. M. - ‘Discrete Event System Simulation’ - Pearson Education - 2001 - 3rd Edition.

Viswanathan N. and Narahari Y. - ‘Performance Modeling of Automated Manufacturing

Vehicle Body Engineering	
Course Code: 23MEEV03	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. Understand different aspects of car body and bus body types
2. Understand different types and dimensions of commercial vehicle.
3. Understand driver's cab design regulations.
4. Know the role of various aerodynamic forces and moments, measuring instruments

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

1. Describe different aspects of car body and bus body types.
2. Illustrate different types and dimensions of commercial vehicle.
3. Design driver's cab in relation to controls.
4. Illustrate the role of various aerodynamic forces and moments, measuring instruments

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	CLO1	CLO 2	CLO3	CLO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

COURSE CONTENTS

UNIT 1

Car Body Details

Types of Car body – Saloon, convertibles, Limousine, Estate Van, Racing and Sports car – Visibility regulations, driver's visibility, improvement in visibility and tests for visibility. Driver seat design –Car body construction-Various panels in car bodies. Safety aspect of car body.

UNIT 2

Car Body Details

Types of Car body – Saloon, convertibles, Limousine, Estate Van, Racing and Sports car – Visibility regulations, driver's visibility, improvement in visibility and tests for visibility. Driver seat design -Car body construction-Various panels in car bodies. Safety aspect of car body.

UNIT 3

Commercial Vehicle Details

Types of commercial vehicle bodies – Light commercial vehicle body. Construction details of commercial vehicle body – Flat platform body, Trailer, Tipper body and Tanker body – Dimensions of driver’s seat in relation to controls – Drivers cab design – Regulations.

UNIT 4

Vehicle Aerodynamics

Objectives, Vehicle drag and types. Various types of forces and moments. Effects of forces and moments. Side wind effects on forces and moments. Various body optimization techniques for minimum drag. Wind tunnels –Principle of operation, Types. Wind tunnel testing such as: Flow visualization techniques, Airflow management test– measurement of various forces and moments by using wind tunnel.

Text Books

1. Powloski, J., “Vehicle Body Engineering”, Business Books Ltd., 1998.

2. James E Duffy, “Body Repair Technology for 4-Wheelers”, Cengage Learning, 2009.

Reference Books

1. Miles, G.J., “Body construction and design”, Illiffe Books Butterworth & Co., 1991.

2. John Fenton, “Vehicle Body layout and analysis”, Mechanical Engg. Publication Ltd., London, 1992.

3. Braithwaite, J.B., “Vehicle Body building and drawing”, Heinemann Educational Books Ltd., London, 1997.

4. Dieler Anselm., The passenger car body, SAE International, 2000.

AUTOMOTIVE TRANSMISSION SYSTEM	
Course Code: 23MEEV04	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To familiarize students with origin of basic transmission system such as Clutch and gear box, Hydrodynamic transmission, Epicyclic gearboxes, Automatic transmission applications & Hydrostatic and electric drive.
2. To familiarize students with the working principle of different automotive transmission system.
3. To impart students with the knowledge of design parameters of automotive transmission systems.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1. Understand the basic working principles of basic elements of automobile transmission system, Classification, Construction of clutch, gear box.
2. Understanding of Constructional details, comparison of different types of drives such as hydrodynamic, hydrostatic, electric and automatic drives.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)	
	CLO 1	CLO 2
CO 1	√	
CO 2	√	√
CO 3		√

Course Content

UNIT-I: Clutch and gear box: Requirement of transmission system, Different types of clutches, principle & Construction of Single plate coil spring and Diaphragm spring clutches, Need and Objectives of Gear box. Construction and operation of Sliding mesh, Constant mesh and Synchromesh gearboxes. Determination of gear ratios for vehicles. Performance characteristics in different speeds. Problems on performance of automobile such as Resistance to motion, Tractive effort, Engine speed & Power and acceleration.

UNIT-II: Hydrodynamic transmission: Fluid coupling-Principle-Constructional details. Torque capacity. Performance characteristics. Reduction of drag torque in fluid coupling. Torque converter Principle constructional details, performance characteristics. Multistage torque converters and Polyphase torque converters.

UNIT-III: Epicyclical gearboxes used in automatic transmission: Principle of Planetary gear trains – Wilson Gear box, Octal electromagnetic transmission Hydraulic control system for Automatic Transmission.

UNIT-IV: Automatic transmission applications: Need for automatic transmission, Four speed longitudinally mounted automatic transmission – Chevrolet "Turboglide" Transmission, Continuously Variable Transmission (CVT) – Types – Operations of a typical CVT.

UNIT-V: Hydrostatic and electric drive: Hydrostatic drive; various types of hydrostatic systems – Principles of Hydrostatic drive system. Advantages and limitations. Comparison of hydrostatic drive with hydrodynamic drive, construction and working of typical Janny hydrostatic drive. Electric drive-types - Principle of early and modified Ward Leonard Control system-Advantages & limitations.

Reference Books:

1. Heldt, P.M., "Torque converters", Chilton Book Co., 1962.
2. Newton and Steeds, "Motor vehicles", Illiffe Publishers, 1985.
3. Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMKPublishers, 2013.
4. Hydrostatic transmissions for vehicle applications, I Mech E Conference, 1981-88.
5. Crouse,W.H., Anglin,D.L.," Automotive Transmission and Power Trainsconstruction", McGraw Hill, 1976.
6. Heinz Heisler, "Advance vehicle Technology", Butterworth-Heinemann, 2002.

Text Books:

1. Dr. Kripal Singh, Automobile Engineering-Vol. 1, 13th Edition, Standard PublishersDistributors
2. N. K. Giri, Automotive Mechanics, Khanna Publishers, Delhi, Eighth Edition

FUEL CELL AND APPLICATIONS	
Course Code: 23MEEV05	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To understand the fundamentals of fuel cell technologies
2. To understand the thermodynamics and kinetics of fuel cell
3. To study the working of varioustypes of fuel cell
4. To analyze the cost effectiveness and eco-friendliness of Fuel Cells

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

1. Identify the different types of fuel cells and their applications.
2. Understand the factors that affect the kinetics of fuel cell reactions.
3. Select the appropriate type of fuel cell for a given application.
4. Compare the cost of fuel cells to other energy sources

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	CLO1	CLO 2	CLO3	CLO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

COURSE CONTENTS

UNIT 1

INTRODUCTION AND OVERVIEW OF FUEL CELLS

Overview of fuel cells – Need of fuel cell, History, Principle and overview of fuel cell, Basicelectrochemistry for all the fuel cells, Low and high temperature fuel cells; Fuel cell thermodynamics-heat, work potentials, prediction of reversible voltage, Nernst equation; Effect of temperature, pressure, concentration on Nernst potential fuel cell efficiency, Concept of electrochemical potential.

UNIT 2

FUEL CELL TYPES

Types of fuel cells – Alkaline Fuel Cell, Phosphoric Acid Fuel Cell, Solid Oxide fuel cell, Molten Carbonate fuel cell, Direct Methanol Fuel Cell, Proton Exchange Membrane Fuel Cell – relativemerits and demerits, comparison on battery Vs fuel cell.

UNIT 3

FUEL CELL COMPONENTS AND PERFORMANCE

Fuel cell performance characteristics – current/voltage, voltage efficiency and power density, ohmic resistance, Butler-Volmer equation; Tafel equation, kinetic performance, mass transfer effects – membrane electrode assembly components, fuel cell stack, bi-polar plate, humidifiers and cooling plates.

UNIT 4

FUELING

Hydrogen storage technology – pressure cylinders, liquid hydrogen, metal hydrides, carbon fibers – reformer technology – steam reforming, partial oxidation, auto thermal reforming – CO removal, fuel cell technology based on bio-mass.

UNIT 5

APPLICATION OF FUEL CELL AND ECONOMICS

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space, Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

Text Books

5. Fuel Cells for automotive applications, Professional Engineering Publishing UK. ISBN 1-86058-4233, 2004.
6. Larminie J. and Dicks A, Fuel Cell Systems Explained, 2nd Edition, Wiley, 2003.

Reference Books

1. Xianguo Li, Principles of Fuel Cells, Taylor and Francis, 2005.
2. Srinivasan S, Fuel Cells: From Fundamentals to Applications, Springer, 2006.
3. Hayre, R. P, Cha S, Colella W.,Prinz F. B, Fuel Cell Fundamentals, Wiley, NY ,2006.
4. Basu, S. (Ed) Fuel Cell Science and Technology, Springer, N.Y, 2007.

PROGRAMMABLE LOGIC CONTROL	
Course Code:23MEPE13	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Describe the purpose of each of the major PLC components
2. Identify types of signals used by PLC and discuss how they are handled

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1. Students will be able to describe typical components of a Programmable Logic Controller.
2. Students will be able to explain the basic concepts of a Programmable Logic Controller
3. Students will be able to state basic PLC terminology and their meanings.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	✓

Unit I

Introduction of PLC, Parts of PLC, Principles of operation, PLC sizes, PLC. Hardware components: I/O section, Analog I/O section, Analog I/O modules, digital I/O modules

Unit II

CPU

Processor memory module, Programming devices, Diagnostics of PLCs with Computers, PLC programming: Simple instructions Programming, EXAMINE ON and EXAMINE OFF instructions

Unit III

Electromagnetic control relays, Motor starters, Manually operated switches, Mechanically operated and Proximity switches, Output control devices, Latching relays, PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram, Timer instructions, ON DELAY timer and OFF DELAY timer, counter instructions, Up/Down counters. Timer and Counter applications program, control instructions, Data manipulating instructions, math instructions

Unit IV

Applications of PLC: Simple materials handling applications, Automatic control of warehouse, door, Automatic lubricating oil supplier, Conveyor belt motor control, Automatic car, washing machine, Bottle label detection, Process control application, PID control of continuous processes, Networking of PLCs

Unit V

Controlling a robot with a PLC, PLC data move, jump functions, SKIP and MCR function, PLC arithmetic, number comparison, PLC Installation, troubleshooting and maintains.

Text Book

1. F D. Petruzella, Programmable Logic Controllers, McGraw- Hills Publications, 4 th edition, 2010.

2. Siemens, PLC Handbook.

References Book

1. W I. Fletcher, An Engineering Approach to Digital Design", Prentice Hall of India Publishers, New Delhi, 3 rd edition, 1999.

2. C H. Roth, Fundamentals of Logic Design,, Jaico Publishing house, 4 th Edition, 1999.

3. Reis & Reis, Programmable Logic Controllers, PHI Learning Publications, 5th edition, 2002.

Vehicle Electrical Power systems	
Course Code: 23MEEV06	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Circuit, Sensor/ Transducer and Control systems	

COURSE OBJECTIVES (CO)

1) To familiarize students with fundamentals of Vehicle Electrical Power systems means Introduction of automobile system, Lighting System, Electrical Accessories, Electronic Devices and Electronics and Computer Application in Automobiles.
2) To familiarize students with the working principle of Introduction of automobile system, Lighting System, Electrical Accessories, Electronic Devices and Electronics and Computer Application in Automobiles.
3) To impart students with the knowledge of design parameters of Vehicle Electrical Power systems.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1) Evaluate the Lighting System, Electrical Accessories and Electronic Devices of automobile.
2) Acquire knowledge of various Automotive Electrical Power systems.
3) Design the basic modeling and Vehicle Electrical Power systems.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)		
	CLO 1	CLO 2	CLO3
CO 1	√		
CO 2	√	√	√
CO 3		√	√

Course Content

Unit-I

Introduction:

Various Electrical components/system in Automobile, their function and demands, earth return system, types of earthing, 6V, 12V system.

Unit-II

Lighting System:

Various lighting circuits, head lamp, types and constructional details, sealed beam, double filaments, asymmetric and dual units, vertical and side control lamps, fog light, side light, break light, Instrument light, Indicator light, reversing light, lamp mounting.

Wiring: HT and LT, their specifications, cable colour codes, wiring harness, cable connections, wiring diagrams of car and two wheeler, Fuses, faults and rectification.

Unit-III

Electrical Accessories:

Fuel gauges, bimetallic and balancing coil type, Air pressure gauges, temperature gauges, Ammeter, warning, Light speedometer, wind speedometer, wind screen wipers, horns, horn relay, electric fuel pump, Faults and rectification.

Miscellaneous Electric Equipment:

Impulse speedometer, tachometer, heaters, defrosters, Air conditioner and Electric Door locks, Window actuation, Seat adjustments.

Unit- IV

Electronic Devices:

Familiarization with automobile electronic devices, Sensoring units, Computer controlled sensors.

Unit- V

Electronics and Computer Application in Automobiles:

Introduction to circuit symbols: Integrated circuits, Amplifiers, filters stepper and synchronous motors, Logic gates, Combinational and sequential logics, Flip flops sensors, Analog and digital devices, converters, signal conditioners, communication chips, multiplexed wiring working of ECU, microprocessor and its applications, Concept of operation by wire.

Text Books

1. William B. Ribbens, Understanding Automotive Electronics, Butterworth-Heinemann publications, 7th Edition, 2012.
2. Walter E, Billiet and Leslie .F, Goings, 'Automotive Electric Systems', American Technical Society, Chicago, 1971.
3. Judge.A.W, 'Modern Electric Equipments for Automobiles', Chapman and Hall, London, 1975.
4. Bechtold, Understanding Automotive Electronic, SAE, 2010.
5. BOSCH, Automotive Hand Book, Bentely Publishers, Germany, 9th Edition, 2014.

Reference Books

1. Sonde.B.S., 'Transducers and Display System', Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1977.
2. W.F. Walter, 'Electronic Measurements', Macmillan Press Ltd., London.
3. E.Dushin, 'Basic Metrology and Electrical Measurements', MIR Publishers, Moscow, 1989.
4. Young A.P., Griffiths L., Automotive Electrical Equipment, ELBS & New Press, 2010.
5. Tom Weather Jr., Cland C. Hunter, Automotive computers and control system, Prentice Hall Inc., New Jersey,2009.
6. Crouse W.H., Automobile Electrical Equipment, McGraw Hill Co. Inc., New York, 2005.

Electric Vehicle Machines and Drives	
Course Code: 23MEEV07	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To understand the concept of electric vehicles.
2. To study about the motors & drives for electric vehicles.
3. To understand the electronics and sensors in electric vehicles
4. To understand the concept of hybrid vehicles.
5. To study about fuel cell for electric vehicles.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

1. Describe about working principle of electric vehicles.
2. Explain the construction and working principle of various motors used in electric vehicles.
3. Understand about working principle of electronics and sensor less control in electric vehicles.
4. Describe the different types and working principle of hybrid vehicles.
5. Illustrate the various types and working principle of fuel cells.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	COL1	COL 2	COL3	COL 4	COL 5
CO 1	√				
CO 2		√			
CO 3			√		
CO 4				√	
CO 5					√

COURSE CONTENTS

UNIT – I

Introduction to Electric Vehicles

Concept of Electrified transportation, Past, present status of electric vehicles, Recent developments and trends in electric vehicles, Comparison of EVs and IC Engine vehicles, Understanding electric vehicle components, Basic EV components and architecture, Autonomy and vehicle computing needs.

Unit-II

Electric Vehicle Motors

Concept of EV motors, Classification of EV motors, and Comparison of Electric motors for EV applications, Recent EV motors, BLDC and SRM, axial flux motor. Introduction to power electronics converters, DC-DC converter, speed control of dc motor, BLDC motor driving schemes

Unit-III

Electronics and Sensor-less control in EV

Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self- drive Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance-

Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.

Unit-IV

Hybrid Vehicles

Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series,

Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy,Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.

Unit-V

Fuel Cells for Electric vehicles

Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fueland Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.

Text Books

1.C.C.Chan, K.T.Chau. Modern Electric Vehicle Technology, Oxford University Press, NY 2001

2. M.Ehsani, Y.Gao, S.E.Gay, A.Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Fundamentals, Theory and Design, CRC Press, 2004

Reference Books

1. James Larminie, John Lowry. Electric Vehicle Technology Explained. Wiley

2.. NPTEL Course on Electric Vehicles – Part 1 by Dr. Amit Jain, IIT Delhi.

VEHICLE MANAGEMENT AND CONTROL	
Course Code: 23MEEV08	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To understand the basic control systems in power train
2. To recognize the electronically controlled system
3. To understand the body electronics and lighting in electrical vehicle
4. To identify the motor and control systems in EV
5. To know the requirement for infotainment and display

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

1. Comprehend the basics of power train modules in EV and HEV
2. Recognize the electronically controlled system used in advanced driver assistance system
3. Identify the body electronics and lighting requirement for EV
4. Select the type of motors and control system for EV application
5. Recognize the need of infotainment, display and synchronization for effective automated transport system.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	COL1	COL 2	COL3	COL 4	COL 5
CO 1	√				
CO 2		√			
CO 3			√		
CO 4				√	
CO 5					√

COURSE CONTENTS

UNIT – I

EV, HEV and Power Train

1 phase and 3 phase AC analog control, 1 phase and 3 phase AC digital control, battery pack passive balancing, DC-DC converter, automatic transmission, Battery control unit, DC fast charging, drive line components, electric power steering, fuel cell control unit, sensors in power train, Block diagram of VCU, Virtual engine sound system.

Unit-II

Advanced driver assistant systems (ADAS): ADAS domain controller, automotive thermal camera, camera module without processing, conditionally automated drive controller, drive assist ECU, Drive monitoring, LiDAR.

Unit-III

Body Electronics and Lighting : Automotive HVAC compressor Module, Automotive HVAC control module, Automotive HVAC sensors, Automotive gateway, heater module, Body control module, DC/AC inverter, door handle module, gesturing, headlight, Interior Light, Obstacle detection sensor, power distribution box, rear light, wiper module, sliding door module, smart glass module, seat comfort module, passive entry passive start

Unit-IV

Motor control and Drive:

Motor types: ACIM control, Brushed DC motor Control, PMSM control, Stepper Motor control, Switched reluctance Motor control.

Unit-V

Infotainment and cluster:

Head unit, audio amplifiers, telematics, USB media Hub, wireless charging

Display: Graphical user interface, Human machine interface for diagnostic tools

Text Books

1. Bosch Automotive Handbook, Sixth edition,2004.

Reference

1. https://www.ti.com/applications/automotive/overview.html
2. https://www.microchip.com/en-us/solutions/automotive-and-transportation
3. https://www.microchip.com/en-us/solutions/motor-control-and-drive
4. https://www.microchip.com/en-us/solutions/power-management-and-conversion
5. https://www.microchip.com/en-us/solutions/displays

Automotive Instrumentation and Control	
Course Code: 23MEEV09	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Sensor/ Transducer, Fundamental of engineering mechanics, Control systems design	

COURSE OBJECTIVES (CO)

1) To familiarize students with fundamentals of Automotive Instrumentation and Control means Introduction of automobile system, Engine management systems, Vehicle power train and motion control, Active and passive safety system and Automotive standards and protocols.
2) To familiarize students with the working principle of Introduction of automobile system, Engine management systems, Vehicle power train and motion control, Active and passive safety system and Automotive standards and protocols.
3) To impart students with the knowledge of design parameters of Automotive Instrumentation and Control.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1) Evaluate the sensor and measuring system of automobile.
2) Acquire knowledge of various automotive standards and Protocols.
3) Design the basic modeling and control scheme for automotive systems.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)		
	CLO 1	CLO 2	CLO3
CO 1	√		
CO 2	√	√	√
CO 3		√	√

Course Content

Unit-I

Introduction of automobile system Current trends in automobiles with emphasis on increasing role of electronics and software, overview of generic automotive control ECU functioning, overview of typical automotive subsystems and components, AUTOSAR.

Unit-II

Engine management systems Basic sensor arrangement, types of sensors such as oxygen sensors, crank angle position sensors, Fuel metering/ vehicle speed sensors, flow sensor, temperature, air mass flow sensors, throttle position sensor, solenoids etc., algorithms for engine control including open loop and closed loop control system, electronic ignition, EGR for exhaust emission control.

Unit-III

Vehicle power train and motion control Electronic transmission control, adaptive power Steering, adaptive cruise control, safety and comfort systems, anti-lock braking, traction control and electronic stability, active suspension control.

Unit-IV

Active and passive safety system Body electronics including lighting control, remote keyless entry, immobilizers etc., electronic instrument clusters and dashboard electronics, aspects of hardware design for automotive including electro-magnetic interference suppression, electromagnetic compatibility etc., (ABS) antilock braking system, (ESP) electronic stability program, air bags.

Unit-V

Automotive standards and protocols Automotive standards like CAN protocol, Lin protocol, flex ray, OBD-II, CAN FD, automotive Ethernet etc. Automotive standards like MISRA, functional safety standards (ISO 26262).

Text Books:

1. Understanding Automotive Electronics by William B. Ribbens, Butterworth Heinemann Woburn, 6th ed., 2003

2. Sensors Applications, Sensors for Automotive Technology by Jiri Marek, Hans Peter Trah, Wiley, 1st Edition

3. U.Kiencke, and L. Nielson, Automotive Control Systems, Springer Verlag Berlin, 2000

Reference Books:

1. Automotive Electrical Equipment by Young A.P., Griffiths, ELBS & New Press, 1999.

2. Automotive computers and control system by Tom Weather Jr. & Cland C. Hunter, Prentice Hall Inc., New Jersey.

3. Automobile Electrical Equipment by Crouse W.H., McGraw Hill Co. Inc., New York, 1995.

4. Understanding Automotive Electronic by Bechhold, SAE, 1998.

5. Automotive Hand Book by Robert Boshe, Bentely Publishers, 5th ed. Germany, 2005.

COMPOSITE MATERIALS	
Course Code: 23MEPE19	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

5. Terms associated with composite materials
6. Basics of composite manufacturing
7. Different kinds of composite materials and their testing standards
8. Mechanics of damage in composite materials.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course, student should be able

6. To understand the terms associated with composite materials
7. To differentiate between different types of composite materials
8. To manufacture composite materials by VARTM process
9. To understand testing standards of composite materials
10. To apply failure theories to composite materials.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO 1	CLO2	CLO3	CLO4	CLO5
CO1	⍰				
CO2		⍰			
CO3			⍰		
CO4				⍰	⍰

COURSE CONTENTS

Unit-I Introduction

Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials,
Types of fibres, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres.

Unit-II Various types of composites

Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

Unit-III Fabrication methods

Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

Unit-IV Testing of Composites

Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing.

Unit-V Mechanics

Failure Theories and Strength of Unidirectional Lamina, Design consideration, analysis of laminates after initial failure, interlaminar stresses, fracture mechanics, experimental characterization, Micromechanics, Factors influencing strength and stiffness failure modes,

TEXT BOOK

4. Mechanics of composite materials and structures, M. Mukhopadhyay. Universities Press, 2012
5. FIBER REINFORCED COMPOSITES: Materials, Manufacturing, and Design, P.K. Mallick, CRC Press, 3rd Edition 2007,
6. Mechanics of Composite Materials, R.M. Jones, Taylor and Francis, 2nd Edition, 1999

REFERENCE BOOK

5. Materials characterization, Vol. 10, ASM hand book
6. Mechanical Metallurgy by G. Dieter Mc-Graw Hill
7. Thermal Analysis of Materials by R.F. Speyer, Marcel Decker
8. Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall India

EV Charging Technology	
Course Code: 23MEEV10	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To study the electric vehicle battery requirement and battery efficiency
2. To explain electric vehicle battery charging methods
3. To understand electric vehicle fast charging & discharging behaviour
4. To understand electric vehicle battery performance

COURSE LEARNING OUTCOMES (CLO)

At the end of the course the student will be able to

1. Describe battery basics and its different types used in electric vehicles.
2. Analyze the capacity of different types of batteries used in electric vehicles.
3. Analyze the impacts of rate of charge effect and environmental effects in different battery charging methods.
4. Compare the fast charging and discharging behavior of different types of batteries.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

COURSE CONTENTS

Unit-I

ELECTRIC VEHICLE BATTERIES: Electric Vehicle Operation, Battery Basics, Introduction to Electric Vehicle Batteries, Fuel Cell Technology, Choice of a Battery Type for Electric Vehicles

ELECTRIC VEHICLE BATTERY EFFICIENCY: Effects of VRLA Battery Formation on Electric Vehicle Performance, Regenerative Braking, Electric Vehicle Body and Frame, Fluids, Lubricants, and Coolants, Effects of Current Density on Battery Formation, Effects of Excessive Heat on Battery Cycle Life, Battery Storage, The Lithium-ion Battery, Traction Battery Pack Design

Unit-II

ELECTRIC VEHICLE BATTERY CHARGING

Charging NiMH Batteries, Rate of Charge Effect on Charge Acceptance Efficiency of Traction, Battery

Packs, Environmental Influences on Charging, Charging Methods for NiMH Batteries, Charging Technology, Battery Pack Corrective Actions

Unit III

ELECTRIC VEHICLE BATTERY FAST CHARGING

On-board & off-board charging, The Fast Charging Process, Fast Charging Strategies, The Fast Charger Configuration, Using Equalizing/Leveling Chargers, Inductive Charging—Making Recharging Easier, Range Testing of Electric Vehicles Using Fast Charging, Electric Vehicle Speedometer Calibration. Wireless Charging

Unit-IV

ELECTRIC VEHICLE BATTERY DISCHARGING

Definition of NiMH Battery Capacity, Discharge Capacity Behavior, Discharge Characteristics of Li-ion Battery, Discharge of an Electric Vehicle Battery Pack, Cold-Weather Impact on Electric Vehicle Battery Discharge.

Unit-V

ELECTRIC VEHICLE BATTERY PERFORMANCE

The Battery Performance Management System, BPMS Thermal Management System, The BPMS Charging Control, High-Voltage Cabling and Disconnects, Safety in Battery Design, Battery Pack Safety-Electrolyte Spillage and Electric Shock, Charging Technology, Electrical Insulation Breakdown Detection, Electrical Vehicle Component Tests, Building Standards, Ventilation

Text / Reference Books

1. Electric vehicle battery systems by Sandeep Dhameja, Newnes Publishing, 2002.

AUTONOMOUS VEHICLES	
Course Code: 23MEEV11	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To understand the hardware and software components of an autonomous vehicle
2. To design and develop state estimation and localization techniques for an autonomous vehicle
3. To design and develop convolutional nueral networks for visual perception of an autonomous vehicle
4. To design and develop sensor

COURSE LEARNING OUTCOMES (CLO)

At the end of the course the student will be able to

1. Understand hardware and software components in an autonomous vehicle
2. Develop state estimation and localization techniques for an autonomous vehicle
3. Build, compare and contrast feedforward neural networks
4. Build, compare and contrast convolutional neural networks for visual perception of an autonomous vehicle

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

COURSE CONTENTS

Unit-I

Introduction – Terminology, Design consideration, Safety assessment. Commonly used hardware, main components of software stack, Vehicle modelling and control, safety frameworks and current industry practices.

Unit-II

State Estimation and Localization – Least squares – Vehicle localization sensors – GPS and IMU – Extended Kalman filter, unscented Kalman filter – LIDAR scan matching, iterative Closest Point Algorithm – Multiple sensor fusion for vehicle state estimation and localization

Unit III

Feedforward neural networks – Review of Deep Learning, Multilayer Perceptron, Optimization, Stochastic Gradient Descent, Back propagation - Introduction to Convolutional Neural Networks(CNN): Architecture, Convolution/Pooling layers – Understanding and Visualizing CNN

Unit-IV

Objective Functions for Autonomous Driving, Hierarchical Motion Planning - Occupancy Grids, Populating Occupancy Grids from LIDAR Scan Data, Occupancy Grid Updates,

Unit-V

High Definition Road Maps, Creating a Road Network Graph, Dijkstra's Shortest Path Search, A* Shortest Path Search, Motion Prediction, Map-Aware Motion Prediction, Time to Collision.

Text / Reference Books

1. *Lipson, H & Kurman, M, Driverless: Intelligent Cars on the Road Ahead, MIT Press, 2016*
2. *Dan Simon, "Optimal State Estimation: Kalman, H∞, and Nonlinear Approaches", John Wiley & Sons, 2006*
3. *Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press 2016*
4. *David A. Forsyth, Jean Ponce, "Computer Vision: A Modern Approach", Pearson, 2003*
5. *Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press 2016*
6. *S. Thrun, W. Burgard, and D. Fox, "Probabilistic robotics", MIT Press, 2010*

LATEST TRENDS IN MECHANICAL ENGINEERING	
Course Code: 23MEPE22	
Credits: 3	
L T P : 0 0 3	
Prerequisite: Strength of Materials	

COURSE OBJECTIVES (CO)

- To know and understand the use of IOT in the field of Manufacturing, agriculture and energy management
- To know about the recent developments in thermos-fluid
- To know about the recent advancement in industrial automation

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to demonstrate:

- Demonstrate the various uses of IOT in different sectors.
- Develop new concepts in recent development in nano fluid and nano fluid energy conversion
- Describe block chain for industrial application.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES		
	CLO1	CLO2	CLO3
CO1			
CO2			
CO3			

COURSE CONTENTS

Unit-I: Introduction to Internet Of Things (IOT) : - Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine to Machine communications, Connected Vehicles, Industrial IoT.

Unit II Rapid Prototyping: - Introduction to Rapid Manufacturing, Customization and Mass Customization, Classification of Rapid Manufacturing Processes (Additive/Subtractive/Formative), Part Deposition Orientation and its Importance, Direct Slicing and STEP related Details Data Format (STEP) and its details related non layered manufacturing processes,

Unit –III: Recent Developments in Thermo-Fluid and Design Fluid:-Introduction to micro fluids, lubrication theory, thin film dynamics, introduction to Nano fluids and Nano fluidic energy conversion.

Unit –IV: Hyperloop Transportation:- Intoduction to Capsule, Geometry, Interior, Compressor, Suspension, Onboard Power, Propulsion. Tube- Geometry,construction, pylons and tunnels, Propulsion- Rotor, Stator, Energy Storage Components, Proulsion for Passenger plus Vehicle system. Safety and Reliablity- Onboard passenger Emergency, Power outage, Capsule Depressurization, Capsule Stranded in Tube, Structural Integrity of tube in Jeopardy, Earthquakes, Reliablity. Economic Considerations.

Unit V Block Chain for Industrial Application :-Re-shaping supply chain management through a public, direct peer-to-peer (P2P)manufacturing ecosystem, Incentivizing Change in Supply Chain Management, Smart Manufacturing Blockchain, Smart Contracts for Transparent Procurement Processing, Smart Business Model for Decentralized Supply Chain Management, Manufacturing Utility Token: Incentivizing Block chain Buy-in, Risk Factors.

TEXT BOOKS

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press)

REFERENCE BOOKS

1. NPTEL Lecture Series and Coursera
2. Decentralized Manufacturing: Smart MFG Tech LTD, V16 - February 15, 2018
3. Hyperloop Alpha: Musk, Elon (August 12, 2013). "Hyperloop Alpha" (PDF). SpaceX. Retrieved August 13, 2013.

3. SPECIALIZATION IN AUTOMATION AND ADVANCED ROBOTICS

PROFESSIONAL ELECTIVE COURSES

Alternative Sources of Energy And System	
Course Code:23MEPE01	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To familiarize the students with the concept of Biomass
2. To familiarize the students with the concept of Solar Energy
3. To familiarize the students with the concept of Wind Energy OTEC
4. To familiarize the students with the concept of Fuel cells
5. To familiarize the students with the concept of MHD systems.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1.To analyze the various renewable energy sources like wind, solar,

2. To analyze the various biomass, Ocean energy, Fuel cells and MHD systems.

3. Exposure on biomass gasification and combustion, Theory of flat plate collectors, photo voltaic, thermal applications and limitations of solar energy are also provided.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	
CO 03		✓	
CO 04			✓
CO 05			✓

COURSE CONTENTS

UNIT 1: BIOMASS

Biomass, sources of biomass - Fermentation, pyrolysis, gasification and combustion - Biogas, calorific value - Power generation, biogas plant design and operation. Thermo-chemical conversion of biomass – Energy balance, conversion to solid, liquid, and gaseous fuel.

UNIT II: SOLAR ENERGY

Solar radiation and its measurements. Flat plate collectors – Photovoltaic and thermal applications – Limitation of solar energy – Theory of flat plate collectors – Solar water heating, solar drying, solar stills, solar cooling and refrigeration.

UNIT III: WIND ENERGY

Basic principle of Wind energy conversion – Wind data and Energy Estimation – Site selection considerations – components of WECS – Advantages and disadvantages of WECS – Design consideration of horizontal axis Machines – Analysis of aerodynamic forces acting on the blade – Performance of wind Machines

UNIT IV: OCEAN ENERGY

Ocean Thermal Energy Conversion - Wave and tidal energy - Availability, geographical distribution - Power generation using OTEC - Scope and economics - Geothermal energy, availability.

UNIT V: ELECTROCHEMICAL ENERGY SOURCES - BATTERIES

Cell and batteries – types of batteries, Primary batteries – Lechalanche cell (dry cell), Lithium cell, Secondary batteries(Accumulators) – Lead acid battery, Alkaline battery Ni-Cd battery, , Lithium-ion battery, Fuel cells- H_2 – O_2 fuel cell & Methanol – Oxygen fuel cell, Photovoltaic Cell- Solar Cell.

TEXT BOOKS

1. Rai, G. D., Non-Conventional Energy Sources, Khanna Publishers, 4th edition, New Delhi, 2005.
2. Wakil, M. M. EL., Power Plant Technology, McGraw Hill Book Company, New York, 1984.

REFERENCE BOOKS

1. Soreyson, B., Renewable Energy, Academic Press, 1989.
2. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, ELBS Publication, 1986.

Introduction to Sensors, Actuators & IoT

Course Code:23MEPE02	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To make students know the IoT eco system.
2. To provide an understanding of the technologies and the standards relating to the Internet of Things.
3. To develop skills on IoT technical planning.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

9. To understand the basics of Networking and Security.
10. To understand predecessor of IoT technology and emergence of Internet of Things.
11. To understand architecture for Internet of Things.
12. To recognize various devices, sensors, actuators, and various processing paradigms for IoT

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓

Course Content

UNIT - I

Basics of Networking & Basics of Network Security: Network Types, Layered Network Models, Addressing, Internet of Things TCP/ IP Transport layer, Security, Network Confidentiality, Message Integrity and Authenticity, Digital signatures, Key Management, Internet Security & Firewall.

UNIT - II

Predecessors of IoT & Emergence of IoT–Introduction, Wireless Sensor Networks, Machine-to-Machine Communications, Cyber Physical Systems, Architectural components of CPS, IoT versus M2M, IoT versus CPS, IoT versus WoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components, Addressing Strategies in IoT.

UNIT - III

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing

UNIT - IV

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor

Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations,
UNIT V Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing
Topologies, IoT Device Design and Selection Considerations, Processing Off loading, Off load location, Off load decision making, Off loading considerations.

Text Books:

1. Internet of Things, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, John Wiley & Sons.
2. Sudip Mishra, Anandarup Mukherjee, Arijit Roy: Introduction to IOT, Cambridge University Press.

Reference Books:

1. Bassi, Alessandro, etal, “Enablingthingstotalk”,Springer-VerlagBerlin-2016
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
3. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/ Maker Media Publishers.

Mechanical Behavior and Testing of Materials	
Course Code: 23MEPE03	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To familiarize students with the fundamental concepts of mechanical behavior of materials,
- To familiarize students with the fundamental concepts various mechanical testing
- To familiarize students with the fundamental concepts practices and to apply them to design the materials for various load-bearing structural engineering applications.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

- Understand the basics of elastic and plastic deformation
- Analyse the plasticity, dislocation and strengthening mechanisms
- Understand and analyse the tensile behaviour of materials and correlating with microstructures
- Understand fatigue and creep behaviour and evaluate & design materials for better creep and fatigue resistance

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	COL1	COL 2	COL3	COL 4
CO 1	√			
CO 2		√		√
CO 3			√	

COURSE CONTENTS

Unit-I

Elastic and plastic deformation, stress-strain relationship; plastic deformation of metallic materials, Mohr's circle, Yielding criterion- Von Misses, and maximum-shear-stress/Tresca yielding criterion, failure criteria under combined stresses

Unit-II

Elements of theory of plasticity, dislocation theory, properties of dislocation, stress fields around dislocations, elementary dislocation interactions; application of dislocation theory to work hardening and strengthening mechanisms.

Unit-III

Engineering stress-strain curve, true stress-strain curve, instability in tension, stress distribution at the neck, , testing machines, Tensile properties of important materials.

Unit-IV

Introduction, Brinell, Vickers and Rock well hardness tests, Meyer hardness, analysis of indendation by an indenter, relationship between hardness and the flow curve, microhardness tests, hardness conversion; hardness at elevated temperatures. Introduction to torsion, torsional stresses for large plastic strains, types of torsion failures torsion test vs. tension test, hot torsion testing.

Unit-V

Introduction to fatigue testing, practice and evaluation; fatigue crack growth; low cycle, high cycle fatigue; Introduction to creep; stress rupture testing; creep data extrapolation; fatigue-creep interactions; superplasticity.

Text Books

1. Dieter G. E., 'Mechanical Metallurgy', 3 rd Edition, McGraw Hill Publications, 2004
2. Dowling NE, Mechanical Behaviour of Materials, 4th Ed, Pearson, 2013

Reference Books

1. Hull, D., Bacon, D.J., Introduction to Dislocations, 5th Ed., Butterworth-Heinemann, 2011
2. Suryanarayana, AVK., 'Testing of Metallic Materials', BS Publications, 2018

Hydraulic Machine	
Course Code:23MEPE05	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

9. To familiarize with conservation laws and dimensional analysis
10. To familiarize flow through closed conduits and hydraulic machines.
11. To familiarize hydraulic turbine.
12. To familiarize hydraulic pumps .

COURSE LEARNING OUTCOMES (CLO)

11. Student will be able to understand fluid principle
12. Student will be able to understand concept of IMPULSE TURBINE
13. Student will be able to understand concept of reaction turbine
14. Student will be able to understand concept of different type of pump
15.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

Course Content

Unit I

IMPACT OF FREE JETS Impulse – momentum principle, jet impingement - on a stationary flat plate, inclined plate and a hinged plate, at the center of a stationary vane, on a moving flat plate, inclined plate, a moving vane and a series of vanes, Jet striking tangentially at the tip of a stationary vane and moving vane(s), jet propulsion of ships.

Unit II

IMPULSE TURBINES Classification – impulse and reaction turbines, water wheels, component parts, construction, operation and governing mechanism of a Pelton wheel, work done, effective head, available head and efficiency of a Pelton wheel, design aspects, speed ratio, flow ratio, jet ratio, number of jets, number of buckets and working proportions,

Unit III

REACTION TURBINES Component parts, construction and operation of a Francis turbine, Propeller,

Kaplan turbine, differences between the Francis and Kaplan turbines, governing mechanism, work done by the turbine runner, working proportions and design parameters, slow, medium and fast runners, degree of reaction, inward/outward flow reaction turbines, construction and operation of a draft tube - its function and different forms, Introduction to new types of turbine, Deriaz (Diagonal), Bulb, Tubular turbines, Problems.

Unit IV

MODEL SIMILITUDE Performance Characteristics and governing of impulse turbines ,Performance Characteristics and Governing of reaction turbine Unit quantities, specific speed and model relationships for turbines, scale effect, cavitations – its causes, harmful effects and prevention, Thomas cavitation factor, permissible installation height, Problems.

Unit V

PUMPS Centrifugal Pumps: Classification, velocity vector diagrams and work done, Similarity relations and specific speed, net positive suction head, cavitation and maximum suction lift, performance characteristics. Brief introduction to axial flow, mixed flow and submersible pumps,

Reciprocating Pumps: Construction and operational details, discharge coefficient, volumetric efficiency and slip, work and power input, characteristic curves, centrifugal vs reciprocating pumps, brief introduction to screw, gear, vane and radial piston pumps.

Text Books :

1. Hydraulics & Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi

2. Hydraulic Machines – Jagdish Lal, Metropolitan

Reference Books :

1. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers

2. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill 3. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons

Industrial Engineering and Operations Research	
Course Code:23MEPE06	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

9. To understand the concepts of Linear programming technique
10. To understand the applications and use of Assignment, Transportation and Replacement models
11. To familiarise with PERT and CPM technique
12. To familiarise with detailed knowledge of Inventory control and queing theory

COURSE LEARNING OUTCOMES (CLO)

Students completing this course will be able to,

1. Formulate real-world problems as a linear programming model and describe the theoretical workings of the graphical and simplex method
2. Understand different queuing situations and find the optimal solutions using models for different situations
3. Understand variety of problems such as assignment, transportation, travelling salesman etc
4. Understand the concept of Queuing Theory

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

COURSE CONTENTS

UNIT I- LINEAR PROGRAMMING Operations research and decision making - Types of mathematical models and constructing the model - Formulation of linear programming problem - Simplex method (Analytical & Graphical) - Two phase and Big M methods.

UNIT II- ASSIGNMENT AND TRANSPORTATION MODELS Assignment models - Transportation problem – North west corner method – Least cost method – Vogel‘s approximation method – Modi method, Unbalance and degeneracy in transportation model. Replacement theory.

UNIT III- SCHEDULING AND NETWORK ANALYSIS Problem of sequencing – Processing n‘ jobs through two machines and three machines - Processing two jobs through ‗m‘ machines. Network analysis –

PERT and CPM.

UNIT IV - Production Planning and Control

Objectives of PPC- Functions of PPC- Aspects of product development and design- Process Planning, Principles of Standardization, specialization, Simplification-Group Technology- Optimum Batch size, ABC analysis-Value engineering, Traceability, Inventory reconciliation.

UNIT V- QUEING THEORY Queuing Theory: Poisson arrivals and exponential service times - Waiting time and idle time cost – Single channel, multi channel problem, Monte Carlo technique applied to Queuing problems

TEXT BOOKS

1. Handy, A. Taha, Operations Research, 5th Edition, Prentice Hall of India, New Delhi, 1995.

2. Philip and Ravindran, "Operational Research ", John Wiley, 1992.

REFERENCE BOOKS

1. Premkumar, Gupta and Hira, Operation Research, S. Chand & Co., New Delhi, 1986.

2. Fredric S. Hilleer and Gerold J. Lieberman, Introduction to Operation Research, 2nd Edition, CBS, 1974.

3. J.K.Sharma, "Operations Research". 6th Edition, Trinity

ROBOT KINEMATICS	
Course Code: 23MEAR01	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- Familiarize with fundamental definitions and classification of robotic arms
- Perform kinematic synthesis and analysis of planar mechanisms serial and parallel robotic manipulators
- To learn about gear trains
- Perform kinematic analysis using software package

COURSE LEARNING OUTCOMES (CLO)

At the end of the course the student will be able to

CO1: Classify and solve for mobility of planar mechanisms, and understand robot anatomy

CO2: Perform forward and inverse kinematics of serial robot manipulator

CO3: Compute Jacobian matrix and solve the singularity problems of serial robot manipulators

CO4: Analyse different types of gear trains

CO5: Model and analyse planar mechanisms using software package

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				√
CO 2		√			
CO 3			√		
CO 4				√	

COURSE CONTENTS

Unit-I

Review of kinematics of robotic systems, Robot classification, Robot anatomy.

Definitions- link, kinematic pair, kinematic chain. Degrees of freedom - mobility –Kutzbach criterion - Grashoff’s law. Kinematic inversions - - mechanical advantage - transmission angle. Rotation matrix, Euler angles, Quaternions, Homogeneous transformation, DH parameters, Joint space and Operational space, forward and Inverse Kinematics of 2-link and 3-link robot manipulators, work volume simulation. Degrees-of-freedom of parallel mechanisms and manipulators, Active and passive joints.

Unit-II

Robot Statics : Geometric Jacobian, Jacobian Computation, kinematic singularities, Analysis of redundancy, Analytical Jacobian, Inverse Kinematics algorithms, Statics, Kineto-static duality, Velocity and force transformations.

Unit III

Robotics Drives : Gears – terminology, fundamental law of gearing, involute profile. Interference and undercutting, minimum number of teeth, contact ratio, bevel helical, spiral and worm gears. Gear Trains – simple, compound and epicyclic gearbox for robotics. Cams – classification of cams and followers, nomenclature, description and analysis of follower motion, pressure angle.

Unit-IV

Mechanisms: Quick return - pantograph - straight line-Ackermann - Shaping machine- Hooke's joint - Toggle Analysis of slider crank and four bar mechanisms - Graphical method for position, velocity, and acceleration. Instantaneous centre - velocity analysis - Kennedy's theorem. - Coriolis component of acceleration – graphical approach for quick return mechanism.

Unit-V

Analysis of complex mechanisms Loop closure method, Synthesis of mechanisms – dimensional and three-point synthesis computer programs for analysis of mechanisms – numerical solution of loop closure equations. Inverse kinematics of parallel manipulators and mechanisms, Direct kinematics of Gough-Stewart platform.

Text Books

1. *Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.*
2. *Craig J. J., Introduction to Robotics: Mechanics and Control, 3rd Edition, Addison-Wesley, Reading, MA, 2005*
3. *Uicker, John Joseph, Gordon R. Pennock, and Joseph Edward Shigley. Theory of machines and mechanisms. Vol. 1. New York, NY: Oxford University Press, 2011.*
4. *Norton, Robert L. Kinematics and dynamics of machinery. McGraw-Hill Higher Education, 2011.*

Reference Books

1. *Ghosh, Amitabha, and Asok K. Mallik.Theory of mechanisms and machines.Affiliated East-West Press Private Limited, 2002.*
2. *Rattan, Sarjit S. Theory of machines.Tata McGraw-Hill Education, 2014.*

SIMULATION MODELLING OF MANUFACTURING SYSTEMS	
Course Code: 23MEPE10	
Credits: 3	
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (CO)

• To impart knowledge in the field of modern methods for simulation and modelling of production systems for industrial needs.

• To focus on technological processes and manufacturing systems and applies the principles of discrete simulation for their modeling using software tool.

• To familiarize with discrete event simulation for modelling & simulation of manufacturing systems.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1: Understand the basic concepts and applications of discrete event simulation

2: Analyze the simulation input data

3: Verify and validate simulation models using statistical techniques

4: Analyze and interpret the simulation output results CO5: Build credible simulation models for real-time applications

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			√
CO 2	√	√	√	
CO 3				√

Unit 1

Introduction: Introduction to manufacturing systems – Introduction to simulation – applications – System and System Environment – Types of Simulation, Plant and process simulation - Simulation procedure – Examples of simulation. Probability distributions: Review of basic probability and statistics – Probability distributions – Random number generators – Testing of Random numbers.

Unit 2

Analysis of Simulation input data: Data Collection – Statistical analysis of numerical data – Tests for Independence and Identically distributed data - Distribution fitting – selecting a distribution in the absence of data – Modelling discrete probabilities – Demonstration of input modelling using Arena

Unit 3

Simulation package. Model Building of Discrete systems: Modelling Paradigms - Modelling of Structural elements and Operational elements – Modelling issues – Model Verification and Validation.

Unit 4

Applications of Simulation in Manufacturing – Manufacturing Modelling Techniques – Modelling Material Handling system – Model building exercises using Arena - Case study. Simulation output analysis:

Unit 5

Design of Simulation Experiments: Determination of warm up period, Run length, Number of replications - Statistical analysis of simulation output – Terminating and Non-Terminating Simulations – Comparing alternative system designs – Variance reduction Techniques – Simulation Optimization.

Text Books

1. Law A. W. and Kelton D. W. - 'Simulation Modeling and Analysis' - McGraw Hill - 2010 - 5th Edition.
2. Kelton D. W., Sadowski R. P. and Sasowski D. A. - 'Simulation with ARENA' - McGraw Hill – 2009.

Reference Books

1. Banks J., Carson J. S., Nelson B. L. and Nicol D. M. - 'Discrete Event System Simulation' - Pearson Education - 2001 - 3rd Edition.
2. Viswanathan N. and Narahari Y. - 'Performance Modeling of Automated Manufacturing

Microprocessor	
Course Code: 23MEAR05	
Credits: 3	
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (CO)

- To demonstrate the various features of microprocessor, memory and I/O devices including concepts of system bus.
- To Identify the hardware elements of 8085 microprocessor including architecture
- To design a given interfacing system using concepts of memory and I/O interfacing.
- To demonstrate the features of advance microprocessors.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

- Demonstrate the various features of microprocessor, memory and I/O devices including concepts of system bus.
- Identify the hardware elements of 8085 microprocessor including architecture and pin functions and programming model including registers, instruction set and addressing modes.
- Select appropriate 8085 instructions based on size and functions to write a given assembly language program.
- Design a given interfacing system using concepts of memory and I/O interfacing.
- Demonstrate the features of advance microprocessors.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)				
	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
CO 1	√			√	
CO 2	√	√			
CO 3			√		
CO 4				√	√

Course Content

Unit I

Introduction to Microprocessor, Components of a Microprocessor: Registers, ALU and control & timing, System bus (data, address and control bus), Microprocessor systems with bus organization

Microprocessor Architecture and Operations, Memory, I/O devices,Memory and I/O operations

Unit II

8085 Microprocessor Architecture, Address, Data And Control Buses, 8085 Pin Functions, De multiplexing of Buses, Generation Of Control Signals, Instruction Cycle, Machine Cycles, T-States, Memory Interfacing

Unit III

Assembly Language Programming Basics, Classification of Instructions, Addressing Modes, 8085 Instruction Set, Instruction And Data Formats,Writing, Assembling & Executing A Program, Debugging The Programs

Writing 8085 assembly language programs with decision, making and looping using data transfer, arithmetic, logical and branch instructions

Unit IV

Writing 8085 assembly language programs with decision, making and looping using data transfer, arithmetic, logical and branch instructions.

Interfacing Concepts, Ports, Interfacing Of I/O Devices, Interrupts In 8085, Programmable Interrupt Controller 8259A, Programmable Peripheral Interface 8255A

Unit V

Advanced Microprocessors : 8086 logical block diagram, segmentation, Pin functions, Minimum and maximum mode, 80286/80386: Overview and architecture, Programming model, Data types and instruction set, segments and its types, segment descriptor, descriptor table and selectors

Text Book

1. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar Pub: Penram International.
2. 8086 Programming and Advance Processor Architecture, Savaliya M. T., WileyIndia

Reference Book

1. The 8088 and 8086 Microprocessors, Triebel & Singh, Pearson Education
2. Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah, Oxford
3. Advanced Microprocessors, Daniel Tabak, McGrawHill
4. Microprocessor & Interfacing - Douglas Hall, TMH

Automation in Manufacturing	
Course Code: 23MEAR06	
Credits: 3	
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (CO)

- To provide the interdisciplinary knowledge in mechanical, electric, and control subsystems for developing automated manufacturing systems
- To introduce various sensing, actuating and control elements of an automated system
- To provide hands on experience on automated system design using Hydraulics, Pneumatics, PLC, Microcontrollers and Robotics

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1: To provide hands on experience on automated system design using Hydraulics, Pneumatics, PLC,
Microcontrollers and Robotics

2: Select and integrate various components of automation like sensors, actuators, PLC
and robots for a given application

3: Develop microcontroller programs to monitor and control the manufacturing systems

4: Design and develop an automated system for a given industrial application

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			√
CO 2	√	√	√	
CO 3			√	

Course Content

Unit I

Introduction to automation – Basic Elements-Levels of automation. Hardware Components of automation sensors and actuators for automation- A/D and D/A Converters- Input and Output devices for discrete data.

Unit II

Application of fluid power in automation- Pneumatic, Hydraulic and Electro- Pneumatic system componentscircuit design for manufacturing automation. Mechanization of parts handling- Parts feeding- Parts sensing, Automated Guided Vehicle.

Unit III

Discrete Process Control- Logic and Sequence Control, Programmable Logic controllers (PLC)-components Ladder logic diagrams- I/O addresses- Timer and counters- PLC Programming applications

Unit IV

Automation: Robot anatomy; Work volume - Drive systems - Sensors for industrial robots. Forward and

reverse kinematics, Robot Drives, End effectors, application of robots in industrial environment, robot

programming, autonomous robots- learning, adaptation, sensing and navigation.

Unit V

Introduction to IoT and IIoT Concepts, Data Monitoring using Arduino/Raspberry Pi: Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters – A/D, D/A Conversion -Analog input / output

Text Book

1. Mikell P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, FifthEdition, Pearson Education, 2019.
2. Robert J. Schilling, “Fundamentals of Robotics, Analysis & Control”, Prentice Hall, 2009.

Reference Book

1. Chang,T.C., Wysk, R.A., and Wang,H.P., “Computer-Aided Manufacturing”, Prentice Hall, 2008.
2. Antony Espossito, “Fluid power with Applications ", Pearson, Seventh Edition., 2009.
3. Nanua Singh, Tatla Dar Singh., “Systems Approach to Computer-Integrated Design and Manufacturing”,
4. John Wiley & Sons, 1995.
5. Gaston C. Hillar, “Internet of Things with Python”, Packt Publishing Limited, 2016

Robot Dynamics and Control	
Course Code: 23MEAR07	
Credits: 3	
L T P : 0 0 3	
Prerequisite: Kinematics of Robotics	

COURSE OBJECTIVES (CO)

- To acquaint students with the fundamentals of robotic dynamics
- To familiarize students with dynamics of the open chains
- To acquaint students with the process of trajectory generation
- To make students understand the motion planning in robots
- To familiarize students with control of robotic system

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to demonstrate:

- The understanding of mechanics of rigid body
- The understanding of open link dynamics
- The planning for trajectory generation and motion
- The process of controlling robotics system

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	CLO1	CLO2	CLO3	CLO4
CO1				
CO2				
CO3				
CO4				
CO5				

COURSE CONTENTS

Unit-I: Configuration Space - Degrees of Freedom of a Rigid Body- Degrees of Freedom of a Robot- Robot Joints - Grubler's Formula - Configuration Space: Topology and Representation - Configuration Space Topology- Configuration Space Representation- Configuration and Velocity Constraints- Task Space and Workspace.

Unit –II: Dynamics of Open Chains- Lagrangian Formulation- Basic Concepts and Motivating Examples- General Formulation- Understanding the Mass Matrix- Lagrangian Dynamics vs. Newton–Euler Dynamics- Dynamics of a Single Rigid Body- Classical Formulation- Twist–Wrench Formulation- Dynamics in Other Frames- Newton–Euler Inverse Dynamics- Derivation-

Newton-Euler Inverse Dynamics Algorithm- Dynamic Equations in Closed Form- Forward Dynamics of Open Chains- Dynamics in the Task Space- Constrained Dynamics - Actuation, Gearing, and Friction- DC Motors and Gearing- Apparent Inertia- Newton–Euler Inverse Dynamics Algorithm Accounting for Motor Inertias and Gearing- Friction- Joint and Link Flexibility

Unit –III: Trajectory Generation – Definitions- Point-to-Point Trajectories- Straight-Line Paths-Time Scaling a Straight-Line Path- Polynomial Via Point Trajectories- Time-Optimal Time Scaling- The $(s, \dot{s})$ Phase Plane- The Time-Scaling Algorithm- A Variation on the Time-Scaling Algorithm- Assumptions and Caveats

Unit –IV: Motion Planning- Overview of Motion Planning- Types of Motion Planning Problems-Properties of Motion Planners- Motion Planning Methods- Foundations- Configuration Space Obstacles- Distance to Obstacles and Collision Detection- Graphs and Trees- Graph Search-Complete Path Planners - Grid Methods- Multi-Resolution Grid Representation- Grid Methods with Motion Constraints - Nonlinear Optimization – Smoothing

Unit -V: Robot Control- Control System Overview- Error Dynamics- Error Response- Linear Error Dynamics- Motion Control with Velocity Inputs- Motion Control of a Single Joint- Motion Control of a Multi-joint Robot- Task-Space Motion Control- Motion Control with Torque or Force Inputs- Motion Control of a Single Joint- Motion Control of a Multi-joint Robot- Task-Space Motion Control- Force Control- Hybrid Motion–Force Control- Natural and Artificial Constraints- A Hybrid Motion–Force Controller- Impedance Control- Impedance-Control Algorithm- Admittance-Control Algorithm- Low-Level Joint Force/Torque Control- Software

TEXT BOOKS

1. Modern Robotics: Mechanics, Planning, and Control, Kevin M. Lynch and Frank C. Park, Cambridge University Press, 2017

PROGRAMMABLE LOGIC CONTROL

Course Code:23MEPE13	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Describe the purpose of each of the major PLC components
2. Identify types of signals used by PLC and discuss how they are handled

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1. Students will be able to describe typical components of a Programmable Logic Controller.
2. Students will be able to explain the basic concepts of a Programmable Logic Controller
3. Students will be able to state basic PLC terminology and their meanings.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	✓

Unit I

Introduction of PLC, Parts of PLC, Principles of operation, PLC sizes, PLC. Hardware components: I/O section, Analog I/O section, Analog I/O modules, digital I/O modules

Unit II

CPU

Processor memory module, Programming devices, Diagnostics of PLCs with Computers, PLC programming: Simple instructions Programming, EXAMINE ON and EXAMINE OFF instructions

Unit III

Electromagnetic control relays, Motor starters, Manually operated switches, Mechanically operated and Proximity switches, Output control devices, Latching relays, PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram, Timer instructions, ON DELAY timer and OFF DELAY timer, counter instructions, Up/Down counters. Timer and Counter applications program, control instructions, Data manipulating instructions, math instructions

Unit IV

Applications of PLC: Simple materials handling applications, Automatic control of warehouse, door, Automatic lubricating oil supplier, Conveyor belt motor control, Automatic car, washing machine, Bottle label detection, Process control application, PID control of continuous processes, Networking of PLCs

Unit V

Controlling a robot with a PLC, PLC data move, jump functions, SKIP and MCR function, PLC arithmetic, number comparison, PLC Installation, troubleshooting and maintains.

Text Book

1. F D. Petruzella, Programmable Logic Controllers, McGraw- Hills Publications, 4 th edition, 2010.
2. Siemens, PLC Handbook.

References Book

1. W I. Fletcher, An Engineering Approach to Digital Design", Prentice Hall of India Publishers, New Delhi, 3 rd edition, 1999.
2. C H. Roth, Fundamentals of Logic Design,, Jaico Publishing house, 4 th Edition, 1999.
3. Reis & Reis, Programmable Logic Controllers, PHI Learning Publications, 5th edition, 2002.

Mobile Robots	
Course Code: 23MEAR08	
Credits: 3	
L T P : 0 0 3	
Prerequisite: Fundamentals of Robotics	

COURSE OBJECTIVES (CO)

- To acquaint students with the fundamentals of mobile robotics
- To familiarize students with control of mobile robots
- To acquaint students with the assembly of mobile robots

COURSE LEARNING OUTCOMES (CLO)

After completing the course, the student should be able to:

- explain the operational principles of (and distinctions between) various types of mobile robot architectures
- give a detailed account of theories and algorithms for mapping and localization
- give a detailed account of theories and algorithms for path and motion planning

  Competence and skills

  After completing the course, the student should be able to:
- independently construct and deploy software for an autonomous mobile robot capable of mapping, localization, path planning, and motion planning
- clearly document theories, algorithms, experiments, and results of a mobile robotics project and present it both orally and in the form of a written report

  Judgement and approach

  After completing the course, the student should be able to:
- discuss ethical problems related to practical applications of mobile robots

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES					
	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6
CO1						
CO2						
CO3						

COURSE CONTENTS

Unit-I: Introduction- Applications of Mobile Robots- Types of Mobile Robots- Automated Guided Vehicles (AGVs)- Service Robots- Cleaning and Lawn Care Robots- Social Robots- Field Robots- Inspection, Reconnaissance, Surveillance, and Exploration Robots- Mobile Robot

Engineering- Mobile Robot Subsystems- Overview of the Text- Fundamentals of Wheeled Mobile Robots.

Unit –II: State Estimation- Mathematics of Pose Estimation- Pose Fixing versus Dead Reckoning- Pose Fixing- Error Propagation in Triangulation- Real Pose Fixing Systems- Dead Reckoning- Real Dead Reckoning Systems- Sensors for State Estimation- Articulation Sensors- Ambient Field Sensors- Inertial Frames of Reference- Inertial Sensors- Inertial Navigation Systems- Introduction- Mathematics of Inertial Navigation- Errors and Aiding in Inertial Navigation- Example: Simple Odometry-Aided Attitude and Heading Reference System- Satellite Navigation Systems- Introduction- Implementation- State Measurement- Performance- Modes of Operation

Unit –III: Perception- Image Processing Operators and Algorithms- Taxonomy of Computer Vision Algorithms- High-Pass Filtering Operators- Low-Pass Operators- Matching Signals and Images- Feature Detection- Region Processing- Physics and Principles of Radiative Sensors- Radiative Sensors- Techniques for Range Sensing- Radiation- Lenses, Filters, and Mirrors- Sensors for Perception- Laser Rangefinders- Ultrasonic Rangefinders- Visible Wavelength Cameras- Mid to Far Infrared Wavelength Cameras- Radars- Aspects of Geometric and Semantic Computer Vision- Pixel Classification- Computational Stereo Vision- Obstacle Detection

Unit –IV: Localization and Mapping- Representation and Issues- Introduction- Representation- Timing and Motion Issues- Related Localization Issues- Structural Aspects -Example: Unmanned Ground Vehicle (UGV) Terrain Mapping- Visual Localization and Motion Estimation- Introduction- Aligning Signals for Localization and Motion Estimation - Matching Features for Localization and Motion Estimation- Searching for the Optimal Pose- Simultaneous Localization and Mapping- Introduction- Global Consistency in Cyclic Maps – Revisiting- EKF SLAM for Discrete Landmarks- Example: Auto surveying of Laser Reflectors

Unit –V: Motion Planning- Introduction- Introducing Path Planning- Formulation of Path Planning- Obstacle-Free Motion Planning- Representation and Search for Global Path Planning - Sequential Motion Planning- Big Ideas in Optimization and Search- Uniform Cost Sequential Planning Algorithms- Weighted Sequential Planning- Representation for Sequential Motion Planning- Real-Time Global Motion Planning: Moving in Unknown and Dynamic Environments- Introduction- Depth-Limited Approaches- Anytime Approaches- Plan Repair Approach: D* Algorithm- Hierarchical Planning

TEXT BOOKS

1. Mobile Robotics- Mathematics, Models, and Methods by Alonzo Kelly, Cambridge University Press-2013

REFERENCE BOOKS

1. Springer Handbook of Robotics
2. Robotics, Vision, and Control: Fundamental Algorithms in MATLAB by Peter Corke
3. Probabilistic Robotics by Sebastian Thrun, Wolfram Burgard and Dieter Fox
4. Introduction to Robotics: Mechanics and Control (3rd Edition) by J.J. Craig

Automotive Control Systems	
Course Code: 23MEAR09	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Circuit, Sensor/ Transducer and Control systems	

COURSE OBJECTIVES (CO)

6. To know the layout and arrangement of principal parts of an automobile.
7. To understand the working of transmission and brake systems.
8. To comprehend the operation and working of steering and suspension systems.
9. To know the Injection system and its advancements.
10. To know the automobile emissions and its effects on the environment.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

6. Identify the different parts of an automobile and its working.
7. Understand the working of transmission and braking systems.
8. Understand the working of steering and suspension systems and their applications.
9. Selection and applications of various types of fuels and injection systems.
10. Analyze the cause of automobile emissions, their effects on the environment, and methods to reduce the emissions.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)				
	CLO 1	CLO 2	CLO3	CLO4	CLO5
CO 1	√				
CO 2		√			
CO 3			√		
CO4				√	
CO5					√

Course Content

Unit-I

Introduction: ENGINE COMPONENTS AND IT'S PRINCIPLE PARTS: Spark Ignition (SI) & Compression Ignition (CI) engines, cylinder – arrangements and their relatives' merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Concept of HCCI engines, Hybrid engines, Twin spark engine, Electric car. COOLING AND LUBRICATION: Cooling requirements, Types of cooling- Thermosiphon system, Forced circulation water cooling system, Water pump, Radiator, Significance of lubrication, Splash and Forced feed system.

Unit-II

TRANSMISSION SYSTEMS: Clutch-types and construction, gearboxes- manual and automatic, gear shift mechanisms, Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints. Differential and rear axle, Hotchkiss Drive, and Torque Tube Drive. BRAKES: Types of brakes, mechanical compressed air, vacuum, and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of the antilock-braking system, ABS Hydraulic Unit, Rear-wheel antilock, & Numerical.

Unit-III

STEERING AND SUSPENSION SYSTEMS: Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Suspension, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel, Air suspension system. IGNITION SYSTEM: Battery Ignition system, Magneto Ignition system, electronic Ignition system.

Unit- IV

SUPERCHARGERS AND TURBOCHARGERS: Naturally aspirated engines, Forced Induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag. FUELS, FUEL SUPPLY SYSTEMS FOR SI AND CI ENGINES: Conventional fuels, Alternative fuels, Normal and abnormal combustion, Cetane and Octane numbers, Fuel mixture requirements for SI engines, Types of carburetors, C.D.& C.C. carburetors, Multi-point, and Single point fuel injection systems, fuel transfer pumps, fuel filters, fuel injection pumps, and injectors. Electronic Injection system, Common Rail Direct Injection System.

Unit- V

AUTOMOTIVE EMISSION CONTROL SYSTEMS: Different air pollutants, formation of photochemical smog and causes. Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Air-injection system, Air-aspirator system, Catalytic converter. EMISSION STANDARDS: Euro I, II, III and IV norms, Bharat Stage II, III, IV norms. Motor Vehicle Act.

Text Books

1. Automobile engineering Vol I and II Kirpal Singh Standard Publishers 12th Edition 2011.
2. Automotive Mechanics S. Srinivasan Tata McGraw Hill 2003 2nd Edition.

Reference Books

1. Automotive Mechanics William H Crouse & Donald L Anglin Tata McGraw Hill Publishing Company Ltd 10th Edition 2007
2. Automotive Mechanics: Principles and Practices, Joseph Heitner D Van Nostrand Company, Inc.
3. Automobile Engineering R. B. Gupta Satya Prakashan 4thedition 1984.
4. Fundamentals of Automobile Engineering K.K.Ramalingam Scitech Publications (India) Pvt. Ltd

ACTUATORS AND DRIVES	
Course Code: 23MEAR10	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To learn about non-electrical actuators
- To learn about electrical actuators
- To learn about drives that control non-electrical actuators
- To learn about drives that control electrical actuators

COURSE LEARNING OUTCOMES (CLO)

At the end of the course, the student will be able to

- Explain the non-electrical actuators.
- Explain the electrical actuators.
- Review the drives for electrical actuators.
- Review the drives for non-electrical actuators.
- Develop drives for actuator control for robotics and automation applications.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
CO 1	√				
CO 2		√			√
CO 3			√		
CO 4				√	

COURSE CONTENTS

Unit-I

Linear Actuators: Linear motors, Solenoids, Pneumatic Actuators: Diaphragm - Pneumatic cylinder, Hydraulic actuators. Mathematical Modelling of Actuators.

Unit-II

Rotary Actuators: Rotating electrical machines, operating principles, main terminology and industrial standards. DC, Synchronous, Induction, Stepper, BLDC, Servo motor: principle of operation, main characteristics and construction, Types, Starting, Speed Control and braking, Efficiency, Testing, Selection considerations.

Unit III

Drives: Introduction, classification of electric drives, Dynamics of Electric drives: Types of loads, Multi quadrant operations, motor dynamics, steady state stability and transient stability.

Unit-IV

Electrical drives with DC, synchronous, induction, stepper, BLDC motors: Basic characteristics, Operating modes, and Different control schemes.

Unit-V

Case study: Sizing for real applications. Electro-hydraulic and Electro-pneumatic control devices.

Text Books

1. S. R. Deb; Sankha Deb. Robotics Technology and Flexible Automation, Second Edition McGraw-Hill Education: New York, 2010.
2. Kothari D.P. and Nagrath I.J., “Electric Machines”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.
3. Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2016.
4. Nathan Ida, Sensors, Actuators, and Their Interfaces- A multidisciplinary introduction, 2nd Edition, IET Digital Library, 2020.

Reference Books

1. *Pillay. S.K, A First Course on Electric Drives, Wilely Eastern Limited, Bombay, 2012*
2. *Stephen J. Chapman, ‘Electric Machinery Fundamentals’4th edition, McGraw Hill Education Pvt. Ltd, 2010.*
3. *Jagadeesha T., “Hydraulics and Pneumatics”, 1st edition, I K International Publishing House, New Delhi, 2015.*

Automotive Instrumentation and Control	
Course Code: 23MEAR11	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Sensor/ Transducer, Fundamental of engineering mechanics, Control systems design	

COURSE OBJECTIVES (CO)

1. To familiarize students with fundamentals of Automotive Instrumentation and Control means Introduction of automobile system, Engine management systems, Vehicle power train and motion control, Active and passive safety system and Automotive standards and protocols.
2. To familiarize students with the working principle of Introduction of automobile system, Engine management systems, Vehicle power train and motion control, Active and passive safety system and Automotive standards and protocols.
3. To impart students with the knowledge of design parameters of Automotive Instrumentation and Control.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1. Evaluate the sensor and measuring system of automobile.
2. Acquire knowledge of various automotive standards and Protocols.
3. Design the basic modeling and control scheme for automotive systems.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)		
	CLO 1	CLO 2	CLO3
CO 1	√		
CO 2	√	√	√
CO 3		√	√

Course Content

Unit-I

Introduction of automobile system Current trends in automobiles with emphasis on increasing role of electronics and software, overview of generic automotive control ECU functioning, overview of typical automotive subsystems and components, AUTOSAR.

Unit-II

Engine management systems Basic sensor arrangement, types of sensors such as oxygen sensors, crank angle position sensors, Fuel metering/ vehicle speed sensors, flow sensor, temperature, air mass flow sensors, throttle position sensor, solenoids etc., algorithms for engine control including open loop and closed loop control system, electronic ignition, EGR for exhaust emission control.

Unit-III

Vehicle power train and motion control Electronic transmission control, adaptive power Steering, adaptive cruise control, safety and comfort systems, anti-lock braking, traction control and electronic stability, active suspension control.

Unit-IV

Active and passive safety system Body electronics including lighting control, remote keyless entry, immobilizers etc., electronic instrument clusters and dashboard electronics, aspects of hardware design for automotive including electro-magnetic interference suppression, electromagnetic compatibility etc., (ABS) antilock braking system, (ESP) electronic stability program, air bags.

Unit-V

Automotive standards and protocols Automotive standards like CAN protocol, Lin protocol, flex ray, OBD-II, CAN FD, automotive Ethernet etc. Automotive standards like MISRA, functional safety standards (ISO 26262).

Text Books:

1. Understanding Automotive Electronics by William B. Ribbens, Butterworth Heinemann Woburn, 6th ed., 2003

2. Sensors Applications, Sensors for Automotive Technology by Jiri Marek, Hans Peter Trah, Wiley, 1st Edition

3. U.Kiencke, and L. Nielson, Automotive Control Systems, Springer Verlag Berlin, 2000

Reference Books:

1. Automotive Electrical Equipment by Young A.P., Griffiths, ELBS & New Press, 1999.

2. Automotive computers and control system by Tom Weather Jr. & Cland C. Hunter, Prentice Hall Inc., New Jersey.

3. Automobile Electrical Equipment by Crouse W.H., McGraw Hill Co. Inc., New York, 1995.

4. Understanding Automotive Electronic by Bechhold, SAE, 1998.

5. Automotive Hand Book by Robert Boshe, Bentely Publishers, 5th ed. Germany, 2005.

INTRODUCTION TO DRONES	
Course Code: 23MEAR12	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

The objective of this course is

- to impart introductory knowledge of Drones,
- Their components and introduction to drone materials.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course the student will be able to

- Understand different drone parts and their contribution for successful flight operation
- Learn various electrical parts of drones
- Learn the criterion for the selection of various drone materials
- Understand the concept of surveying
- Learn the concepts of geographical information systems

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
CO 1	√				
CO 2		√		√	√

COURSE CONTENTS

Unit-I

Introduction to drones and their applications: - Definition of drones, history of drones, India and drones, tinkering and drones.

Unit-II

Key features of drone regulations:- Notification of final regulations for civil use, operational and procedural requirements, no drone zones, operations through digital platform, enforcement actions, relevant sections of aircraft act-1934

Unit III

Structural classification of drones: - fixed wing structure, lighter than air systems, rotary wings aircraft, and applications of drones.

Unit-IV

Components of drones:-classifications of drone structures and their suitability, applications and uses of drone frame materials, classifications and applicability of propeller motors, drone propeller materials, design parameters for propellers, composition and structuring of electronic speed controller, flight control board, characteristics of FCB and their structure

Unit-V

Criterion for material selection for drone design:-description of all components. Surveying, GIS and remote sensing:-surveying and survey equipments, introduction to remote sensing, principles of energy interaction in atmosphere and earth surface, features, digital image processing, GPS, GIS, key components of GIS, functions of GIS, spatial and geo-spatial analysis, integration of GIS and remote sensing with reference to drone technology, introduction to data processing using remote sensing and GIS.

Text Books

1. M.*P.Groover, "Automation, Production Systems, and Computer Integrated Manufacturing," 5th Edition, Pearson Education, 2009.*
2. *Antony Esposito, "Fluid Power with Applications", Pearson, Sixth Edition., 2003.*
3. *W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" – Prentice Hall - 2013 - 5th Edition*

Reference Books

1. *Sullivan James A., "Fluid Power - Theory and Applications", Fourth Edition, Prentice-Hall International, New Jersey, 1998.*
2. *Watton, John. Fundamentals of fluid power control. Vol. 10. Cambridge University Press, 2009.*

COMPUTATIONAL FLUID DYNAMICS	
Course Code:23MEAR13	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To familiarize students with basic concepts of partial differential equations, their applications to CFD problems
- To familiarize students with fundamentals of discretization.
- To familiarize students with the solving procedure of heat transfer and fluid flow problems using FDM and FVM.
- To familiarize students with the problems and limitations and errors involved in solution to CFD problems.

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

- Understand basic concepts of partial differential equations
- Understand fundamentals of discretization and application to CFD problems
- Understand the application of FDM and FVM
- Understand the limitations and errors involved in solution to CFD problems

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNINGOUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

COURSE CONTENTS

UNIT-I

INTRODUCTION: Introduction to C.F.D., Governing Differential Equations of Fluid Dynamics:

Continuity Equation, Navier Stokes Equation, energy equation, Classification of Partial Differential Equations, Boundary and Initial Conditions, Approximate Solutions to Differential Equations

UNIT-II

Governing Equations

Classification of quasi linear partial differential equation, General method of determining the Classification of partial differential equation, hyperbolic, parabolic, elliptic equations.

Fundamentals of Discretization: Finite Element Method, Finite Difference and Finite Volume Method, Consistency, Stability and Convergence.

UNIT-III

Finite Volume Discretization of 2-D unsteady State Diffusion type Problems, Solution of Systems of Linear Algebraic Equations: Elimination Methods, Iterative Methods

UNIT-IV

Heat conduction problem: Solution of One-dimensional heat conduction through a fin, solution of two-dimensional steady state and transient heat conduction problems, heat conduction problems in cylindrical coordinates: axisymmetric and non-axisymmetric problems.

UNIT- V

Fluid flow problem: Viscous incompressible flow, solution of the Couette flow problem by F.D.M., calculation of the flow field using stream function – vorticity method, numerical algorithms for solving complete Navier-Stokes equation – MAC method; SIMPLE method.

Textbook(s)

1.Versteeg, H.K., and Malalasekara, W, “An Introduction to Computational Fluid Dynamics”, The Finite Volume Method, 2007.

2.Moukalled, F., Mangani, L., &Darwish, M. “The finite volume method in computational fluid dynamics. An Advanced Introduction with OpenFOAM and Matlab”, 2016.

Reference(s)

1.Anderson, J. D., & Wendt, J., “Computational fluid dynamics” (Vol. 206). New York: McGraw-Hill, 1995.

2.Niyogi, Chakraborty and Laha, Introduction to Computational Fluid Dynamics, Pearson Education.

INTELLIGENT MANUFACTURING SYSTEMS

Course Code: 23MEAR14	
Credits: 3	
L T P : 3 0 0	
Prerequisite:	

COURSE OBJECTIVES (CO)

• To provide fundamental concepts on intelligent manufacturing system (IMS) to achieve flexible, smart, and reconfigurable manufacturing processes.

• To familiarize various supporting technologies required to implement IMS.

COURSE LEARNING OUTCOMES (CLO)

After learning the course the students should be able to:

1: Explain the various concepts of intelligent manufacturing systems.

2: Elaborate the various components features and its integration for IMS.

3: Choose suitable supporting technologies to enable IMS implementation.

4: Discuss the real time issues in implementations of IMS with suitable case studies.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives (CO)	Course Learning Outcomes (CLO)			
	CLO 1	CLO 2	CLO 3	CLO 4
CO 1	√			√
CO 2	√	√	√	

Course Content

Unit I

Introduction to Manufacturing systems, various subsystems in manufacturing systems, procurement, design, manufacturing, inspections, assembly, prototyping, material handling, storage systems, concept of Intelligent manufacturing: Internet of Things enabled manufacturing, cloud manufacturing. Characteristics of Intelligent manufacturing systems: Intelligent decision making, Application of Artificial Intelligence and Machine learning in developing intelligent manufacturing systems.

Unit II

Component of Intelligent Manufacturing Technologies, Development of Intelligent systems for Design, Process planning, Controls, Scheduling, Quality Management, Maintenance and

Diagnostics. Supporting technologies for IMS: Industry Internet of Things, Cyber Physical Systems, Cloud computing, RFID Technologies, Data Analytics, other Information and Communications Technology.

Unit III

Framework for intelligent manufacturing: Smart design, Smart machines, Smart control, Smart scheduling, Human-Machine collaboration, collaborative robots and other enabling technologies such as AR and VR, Datadriven intelligent manufacturing models, Autonomous intelligent manufacturing units

Unit IV

Applications and case studies in intelligent manufacturing systems implementation, limitation of technologies and other real time issues in implementations of IMS.

Text Book

1. Andrew Kusiak, Intelligent Manufacturing Systems, Prentice Hall international series- industrial & systems engineering, 1990.
2. Intelligent Manufacturing in the Context of Industry 4.0: A Review, Engineering, Elsevier Publications, Volume 3, Issue 5, October 2017, Pages 616-630.

Reference Book

1. Peigen Li, Special Issue: Intelligent Manufacturing, Engineering, Elsevier Publications, 3, 2017, 575.
2. Yubao Chen, Integrated and Intelligent Manufacturing: Perspectives and Enablers, Engineering, Engineering 3, 2017, Pages 588–595.
3. Hamid R. Parsaei and Mohammad Jamshidi, Design and Implementation of Intelligent Manufacturing Systems: From Expert Systems, Neural Networks, to Fuzzy Logic, Prentice Hall Series Publication, 1995.

Jongwon Kim, Manufacturing Systems 1997 - IFAC Proceedings Volumes, Elsevier publications, 1997

Optimization for Robot Modelling	
Course Code: 23MEAR15	
Credits: 3	
L T P : 0 0 3	
Prerequisite:	

COURSE OBJECTIVES (CO)

- To gain knowledge about the need of robotic system optimization
- To understand the optimization techniques in robotics
- To acquire knowledge in robotic structure optimization
- To learn to develop kinematic synthesis

COURSE LEARNING OUTCOMES (CLO)

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to demonstrate:

- Various optimization method in robotics
- Optimization models in robotics

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES	
	CLO1	CLO2
CO1		
CO2		
CO3		
CO4		

COURSE CONTENTS

Unit-I: Introduction

Background- Why Optimization- Application of Optimization in the Industrial Robot Arm- Grinding and Polishing- Cutting- Assembly- Painting- Welding- Optimization and Robot Design- Optimization and Robot Configuration Space

Unit –II: Optimization: Introduction- Ant Algorithm- Ant System- Ant Colony System- Ant Colony Optimization for a Continuous Domain- Flower Pollination Algorithm- Invasive - Bat Algorithm (BATA)- Bees Algorithm (BA)- Cuckoo Search (CS) Particle Swarm Optimization - Multiswarm Optimization- Random Search.

Unit –III: Structural Optimization and Stiffness Analysis

Introduction- Structural Optimization- Structural Optimization of a 7DOF-Type Robot- Stiffness Analysis- Lumped Parameter Model- Method Based on Joint Compliance- Method Based on Joints and Links Compliants- Matrix Structural Analysis- Stiffness of Link and Joint- Methodology.

Unit –IV: Kinematic Synthesis

Introduction- Type Synthesis- Dimensional Synthesis- Genetic Algorithms- Genetic Representation of a Mechanism- Graph Theory- Graph- Incidence- Adjacent Vertices- Adjacent Edge- Self-loop-Parallel Edge- Incidence Matrix- Liu Approach- Planning Method

TEXT & REFERENCE BOOKS

1. Optimization for Robot Modelling with MATLAB by Hazim Nasir Ghafil & Károly Jármai, Springer 2020.
2. Modeling and Optimization of the Aerospace, Robotics, Mechatronics, Machines-Tools, Mechanical Engineering and Human Motricity Fields by Adrian Olaru, Trans Tech Publications Limited 2014.
3. Parallel PnP Robots- Parametric Modeling, Performance Evaluation and Design Optimization by Guanglei Wu, Huiping Shen · 2020
4. Modelling and Control for Intelligent Industrial Systems Adaptive Algorithms in Robotics and Industrial Engineering By Gerasimos Rigatos · 2011
5. Modeling, Simulation and Optimization of Complex Processes Proceedings of the International Conference on High Performance Scientific Computing, March 10-14, 2003, Hanoi, Vietnam.

4. SPECIALIZATION IN ARTIFICIAL INTELLIGENCE (AI) AND MACHINE LEARNING (ML)

PROFESSIONAL ELECTIVE COURSES

Alternative Sources of Energy And System	
Course Code:23MEPE01	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To familiarize the students with the concept of Biomass
2. To familiarize the students with the concept of Solar Energy
3. To familiarize the students with the concept of Wind Energy OTEC
4. To familiarize the students with the concept of Fuel cells
5. To familiarize the students with the concept of MHD systems.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1.To analyze the various renewable energy sources like wind, solar,

2. To analyze the various biomass, Ocean energy, Fuel cells and MHD systems.

3. Exposure on biomass gasification and combustion, Theory of flat plate collectors, photo voltaic, thermal applications and limitations of solar energy are also provided.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	
CO 03		✓	
CO 04			✓
CO 05			✓

COURSE CONTENTS

UNIT 1: BIOMASS

Biomass, sources of biomass - Fermentation, pyrolysis, gasification and combustion - Biogas, calorific value

- Power generation, biogas plant design and operation. Thermo-chemical conversion of biomass – Energy balance, conversion to solid, liquid, and gaseous fuel.

UNIT II: SOLAR ENERGY

Solar radiation and its measurements. Flat plate collectors – Photovoltaic and thermal applications – Limitation of solar energy – Theory of flat plate collectors – Solar water heating, solar drying, solar stills, solar cooling and refrigeration.

UNIT III: WIND ENERGY

Basic principle of Wind energy conversion – Wind data and Energy Estimation – Site selection considerations – components of WECS – Advantages and disadvantages of WECS – Design consideration of horizontal axis Machines – Analysis of aerodynamic forces acting on the blade – Performance of wind Machines

UNIT IV: OCEAN ENERGY

Ocean Thermal Energy Conversion - Wave and tidal energy - Availability, geographical distribution - Power generation using OTEC - Scope and economics - Geothermal energy, availability.

UNIT V: ELECTROCHEMICAL ENERGY SOURCES - BATTERIES

Cell and batteries – types of batteries, Primary batteries – Lechalanche cell (dry cell), Lithium cell, Secondary batteries(Accumulators) – Lead acid battery, Alkaline battery Ni-Cd battery, , Lithium-ion battery, Fuel cells- H_2 – O_2 fuel cell & Methanol – Oxygen fuel cell, Photovoltaic Cell- Solar Cell.

TEXT BOOKS

5. Rai, G. D., Non-Conventional Energy Sources, Khanna Publishers, 4th edition, New Delhi, 2005.
6. Wakil, M. M. EL., Power Plant Technology, McGraw Hill Book Company, New York, 1984.

REFERENCE BOOKS

3. Soreyson, B., Renewable Energy, Academic Press, 1989.

Twidell, J. W. and Weir, A. D., Renewable Energy Resources, ELBS Publication, 1986.

Introduction to Sensors, Actuators & IoT	
Course Code:23MEPE02	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To make students know the IoT eco system.
2. To provide an understanding of the technologies and the standards relating to the Internet of Things.
3. To develop skills on IoT technical planning.

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

13. To understand the basics of Networking and Security.
14. To understand predecessor of IoT technology and emergence of Internet of Things.
15. To understand architecture for Internet of Things.
16. To recognize various devices, sensors, actuators, and various processing paradigms for IoT

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓

Course Content

UNIT - I

Basics of Networking & Basics of Network Security: Network Types, Layered Network Models, Addressing, Internet of Things TCP/ IP Transport layer, Security, Network Confidentiality, Message Integrity and Authenticity, Digital signatures, Key Management, Internet Security & Firewall.

UNIT - II

Predecessors of IoT & Emergence of IoT–Introduction, Wireless Sensor Networks, Machine-to-Machine Communications, Cyber Physical Systems, Architectural components of CPS, IoT versus M2M, IoT versus CPS, IoT versus WoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components, Addressing Strategies in IoT.

UNIT - III

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations, Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing

UNIT - IV

IoT Sensing and Actuation & IoT Processing Topologies and Types: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Sensing Considerations,

UNIT V Actuators, Actuators Types, Actuator Types, Actuator Characteristics, Data Formats, Processing in IoT, Processing

Topologies, IoT Device Design and Selection Considerations, Processing Off loading, Off load location, Off load decision making, Off loading considerations.

Text Books:

1. Internet of Things, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, John Wiley & Sons.

2. Sudip Mishra, Anandarup Mukherjee, Arijit Roy: Introduction to IOT, Cambridge University Press.

Reference Books:

1. Bassi, Alessandro, etal, “Enablingthingstotalk”,Springer-VerlagBerlin-2016

2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017

4. Massimo Banzi, Michael Shiloh Make: Getting Started with the Arduino, Shroff Publisher/ Maker Media Publishers.

Mechanical Behavior and Testing of Materials	
Course Code: 23MEPE03	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- To familiarize students with the fundamental concepts of mechanical behavior of materials,
- To familiarize students with the fundamental concepts various mechanical testing
- To familiarize students with the fundamental concepts practices and to apply them to design the materials for various load-bearing structural engineering applications.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

- Understand the basics of elastic and plastic deformation
- Analyse the plasticity, dislocation and strengthening mechanisms
- Understand and analyse the tensile behaviour of materials and correlating with microstructures
- Understand fatigue and creep behaviour and evaluate & design materials for better creep and fatigue resistance

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES			
	COL1	COL 2	COL3	COL 4
CO 1	√			
CO 2		√		√
CO 3			√	

COURSE CONTENTS

Unit-I

Elastic and plastic deformation, stress-strain relationship; plastic deformation of metallic materials, Mohr's circle, Yielding criterion- Von Misses, and maximum-shear-stress/Tresca yielding criterion, failure criteria under combined stresses

Unit-II

Elements of theory of plasticity, dislocation theory, properties of dislocation, stress fields around dislocations, elementary dislocation interactions; application of dislocation theory to work hardening and strengthening mechanisms.

Unit-III

Engineering stress-strain curve, true stress-strain curve, instability in tension, stress distribution at the neck, , testing machines, Tensile properties of important materials.

Unit-IV

Introduction, Brinell, Vickers and Rock well hardness tests, Meyer hardness, analysis of indendation by an indenter, relationship between hardness and the flow curve, microhardness tests, hardness conversion; hardness at elevated temperatures. Introduction to torsion, torsional stresses for large plastic strains, types of torsion failures torsion test vs. tension test, hot torsion testing.

Unit-V

Introduction to fatigue testing, practice and evaluation; fatigue crack growth; low cycle, high cycle fatigue; Introduction to creep; stress rupture testing; creep data extrapolation; fatigue-creep interactions; superplasticity.

Text Books

7. Dieter G. E., 'Mechanical Metallurgy', 3 rd Edition, McGraw Hill Publications, 2004
8. Dowling NE, Mechanical Behaviour of Materials, 4th Ed, Pearson, 2013

Reference Books

7. Hull, D., Bacon, D.J., Introduction to Dislocations, 5th Ed., Butterworth-Heinemann, 2011
8. Suryanarayana, AVK., 'Testing of Metallic Materials', BS Publications, 2018

INTRODUCTION TO PYTHON PROGRAMMING	
Course Code: 23MEPE04	
Pre-Requisite : NIL	
L T P : 3 0 0	
Credits: 3	

COURSE OBJECTIVES

1. To identify and use various in-built functions, operators and statements supported by python.
2. To learn how to use lists, tuples, and dictionaries in Python programs and to learn how to identify Python object types.
3. To learn how to write or implement control and decision statements in python.
4. To implement the real-use cases of the functions in python.
5. To learn how to build and package python module for reusability and understand the concepts of file handling.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

1. Understand the vision of Python from a global context
2. Understand the content that how to write loops, decision statements, write functions and pass arguments in Python.
3. Learn how to use lists, tuples, and dictionaries in Python programs and to learn how to identify Python object types.
4. Learn how to read and write files in Python. Will learn how to create Pandas DataFrames, calculate aggregates, and merge multiple tables.
5. Understand how to import in-built library and use matplotlib for graph representation and how regular pattern matching will be done.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs):

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					
CO5					

COURSE CONTENTS

UNIT-I INTROUCTION TO PYTHON

Definition with Real Use Cases, History of Python, How Python is installed, Execution of the basic program of the python, Character set, Token, core Data types, Variables, input(), eval() & print() function, Formatting String, Operators and Expressions.

UNIT-II Conditional & Control Statements

Decision Making statements, Conditional Expressions, Boolean type, Boolean

UNIT NUMBER

COURSE CONTENTS

operators, String Operators, While Loop, For Loop, Nested loop, Break & continue Statement, range() Function.

UNIT-III DATA STRUCTURES, FUNCTIONS & OOPS

Syntax and Basics of Functions, Use of functions, Parameters and Arguments, local & global Scope of variable, return statement, recursive function, Str class, inbuilt functions of string, traversal of string, string operator & operations, Creating a list, Tuple, Dictionaries & sets, In-built functions of list, tuple, set & dictionaries, list operators, replacing values in dictionaries, retrieving value from dictionaries, OOPs introduction, classes and objects, methods, operators, inheritance, super() and method() overriding.

UNIT-IV FILE HANDLING & DATA ANALYSIS

Need of File Handling, Different modes of file handling, Read/Write text and numbers to/from a file, Directories on a disk, Introduction of Pandas, Data frames, Series, Data analysis using Pandas. Regular Expression Pattern Matching, Parsing Data, Introduction to Regression, Use Cases of Regression, Types of Regression, Exploratory Data Analysis, Correlation Matrix, Visualisation using Matplotlib, Implementation of Linear Regression.

UNIT-V MACHINE LEARNING

Introduction of Machine Learning, Algorithms Random Forest, Support Vector Machine, Random Forest, Build your own model in python and difference between the Random Forest and decision tree.

TEXT/REFERENCE BOOKS

1. Ashok Namdev Kamthane, Programming and Problem Solving with Python, Mc Graw Hill Education Publication, ISBN(13):978-93-87067-57-8.
2. Allen B. Downey, Think Python, O'Reilly Media
3. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning
4. Python Cookbook , David Beazley & Brian K. Jones (O'Reilly, 3rd edition, 2013)

Hydraulic Machine	
Course Code:23MEPE05	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

- To familiarize with conservation laws and dimensional analysis
- To familiarize flow through closed conduits and hydraulic machines.
- To familiarize hydraulic turbine.
- To familiarize hydraulic pumps .

COURSE LEARNING OUTCOMES (CLO)

- Student will be able to understand fluid principle
- Student will be able to understand concept of IMPULSE TURBINE
- Student will be able to understand concept of reaction turbine
- Student will be able to understand concept of different type of pump

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

Course Content

Unit I

IMPACT OF FREE JETS Impulse – momentum principle, jet impingement - on a stationary flat plate, inclined plate and a hinged plate, at the center of a stationary vane, on a moving flat plate, inclined plate, a moving vane and a series of vanes, Jet striking tangentially at the tip of a stationary vane and moving vane(s), jet propulsion of ships.

Unit II

IMPULSE TURBINES Classification – impulse and reaction turbines, water wheels, component parts, construction, operation and governing mechanism of a Pelton wheel, work done, effective head, available head and efficiency of a Pelton wheel, design aspects, speed ratio, flow ratio, jet ratio, number of jets, number of buckets and working proportions, Unit III

REACTION TURBINES Component parts, construction and operation of a Francis turbine, Propeller, Kaplan turbine, differences between the Francis and Kaplan turbines, governing mechanism, work done by the turbine runner, working proportions and design parameters, slow, medium and fast runners, degree of reaction, inward/outward flow reaction turbines, construction and operation of a draft tube - its function and different forms, Introduction to new types of turbine, Deriaz (Diagonal), Bulb, Tubular turbines, Problems.

Unit IV

MODEL SIMILITUDE Performance Characteristics and governing of impulse turbines ,Performance Characteristics and Governing of reaction turbine Unit quantities, specific speed and model relationships for turbines, scale effect, cavitations – its causes, harmful effects and prevention, Thomas cavitation factor, permissible installation height, Problems.

Unit V

PUMPS Centrifugal Pumps: Classification, velocity vector diagrams and work done, Similarity relations and specific speed, net positive suction head, cavitation and maximum suction lift, performance characteristics. Brief introduction to axial flow, mixed flow and submersible pumps,

Reciprocating Pumps: Construction and operational details, discharge coefficient, volumetric efficiency and slip, work and power input, characteristic curves, centrifugal vs reciprocating pumps, brief introduction to screw, gear, vane and radial piston pumps.

Text Books :

1. Hydraulics & Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi
2. Hydraulic Machines – Jagdish Lal, Metropolitan

Reference Books :

1. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers
2. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill 3. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons

Industrial Engineering and Operations Research

Course Code:23MEPE06	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To understand the concepts of Linear programming technique
2. To understand the applications and use of Assignment, Transportation and Replacement models
3. To familiarise with PERT and CPM technique
4. To familiarise with detailed knowledge of Inventory control and queing theory

COURSE LEARNING OUTCOMES (CLO)

1. Students completing this course will be able to,
2. Understand different queuing situations and find the optimal solutions using models for different situations
3. Understand variety of problems such as assignment, transportation, travelling salesman etc
4. Understand the concept of Queuing Theory

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES(CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03	CLO 04
CO 01	✓			
CO02		✓	✓	
CO 03		✓		✓
CO 04		✓		✓

COURSE CONTENTS

UNIT I- LINEAR PROGRAMMING Operations research and decision making - Types of mathematical models and constructing the model - Formulation of linear programming problem - Simplex method (Analytical & Graphical) - Two phase and Big M methods.

UNIT II- ASSIGNMENT AND TRANSPORTATION MODELS Assignment models - Transportation problem – North west corner method – Least cost method – Vogel's approximation method – Modi method, Unbalance and degeneracy in transportation model. Replacement theory.

UNIT III- SCHEDULING AND NETWORK ANALYSIS Problem of sequencing – Processing n' jobs through two machines and three machines - Processing two jobs through _m' machines. Network analysis – PERT and CPM.

UNIT IV - Production Planning and Control

Objectives of PPC- Functions of PPC- Aspects of product development and design- Process Planning, Principles of Standardization, specialization, Simplification-Group Technology- Optimum Batch size, ABC analysis-Value engineering, Traceability, Inventory reconciliation.

UNIT V- QUEING THEORY Queuing Theory: Poisson arrivals and exponential service times - Waiting time and idle time cost – Single channel, multi channel problem, Monte Carlo technique applied to Queuing problems

TEXT BOOKS

1. Handy, A. Taha, Operations Research, 5th Edition, Prentice Hall of India, New Delhi, 1995.
2. Philip and Ravindran, "Operational Research ", John Wiley, 1992.

REFERENCE BOOKS

1. Premkumar, Gupta and Hira, Operation Research, S. Chand & Co., New Delhi, 1986.
2. Fredric S. Hilleer and Gerold J. Lieberman, Introduction to Operation Research, 2nd Edition, CBS, 1974.
3. J.K.Sharma, "Operations Research". 6th Edition, Trinity

ROBOT KINEMATICS	
Course Code: 23MEAI 01	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

- Familiarize with fundamental definitions and classification of robotic arms
- Perform kinematic synthesis and analysis of planar mechanisms serial and parallel robotic manipulators
- To learn about gear trains
- Perform kinematic analysis using software package

COURSE LEARNING OUTCOMES (CLO)

At the end of the course the student will be able to

CO1: Classify and solve for mobility of planar mechanisms, and understand robot anatomy

CO2: Perform forward and inverse kinematics of serial robot manipulator

CO3: Compute Jacobian matrix and solve the singularity problems of serial robot manipulators

CO4: Analyse different types of gear trains

CO5: Model and analyse planar mechanisms using software package

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

Course Objectives	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				√
CO 2		√			
CO 3			√		
CO 4				√	

COURSE CONTENTS

Unit-I

Review of kinematics of robotic systems, Robot classification, Robot anatomy.

Definitions- link, kinematic pair, kinematic chain. Degrees of freedom - mobility –Kutzbach criterion - Grashoff's law. Kinematic inversions - - mechanical advantage - transmission angle. Rotation matrix, Euler angles, Quaternions, Homogeneous transformation, DH parameters, Joint space and Operational space, forward and Inverse Kinematics of 2-link and 3-link robot manipulators, work volume simulation. Degrees-of-freedom of parallel mechanisms and manipulators, Active and passive joints.

Unit-II

Robot Statics : Geometric Jacobian, Jacobian Computation, kinematic singularities, Analysis of redundancy, Analytical Jacobian, Inverse Kinematics algorithms, Statics, Kineto-static duality, Velocity and force transformations.

Unit III

Robotics Drives : Gears – terminology, fundamental law of gearing, involute profile. Interference and undercutting, minimum number of teeth, contact ratio, bevel helical, spiral and worm gears. Gear Trains – simple, compound and epicyclic gearbox for robotics. Cams – classification of cams and followers, nomenclature, description and analysis of follower motion, pressure angle.

Unit-IV

Mechanisms: Quick return - pantograph - straight line-Ackermann - Shaping machine- Hooke's joint - Toggle Analysis of slider crank and four bar mechanisms - Graphical method for position, velocity, and acceleration. Instantaneous centre - velocity analysis - Kennedy's theorem. - Coriolis component of acceleration – graphical approach for quick return mechanism.

Unit-V

Analysis of complex mechanisms Loop closure method, Synthesis of mechanisms – dimensional and three-point synthesis computer programs for analysis of mechanisms – numerical solution of loop closure equations. Inverse kinematics of parallel manipulators and mechanisms, Direct kinematics of Gough-Stewart platform.

Text Books

5. *Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.*
6. *Craig J. J., Introduction to Robotics: Mechanics and Control, 3rd Edition, Addison-Wesley, Reading, MA, 2005*
7. *Uicker, John Joseph, Gordon R. Pennock, and Joseph Edward Shigley. Theory of machines and mechanisms. Vol. 1. New York, NY: Oxford University Press, 2011.*
8. *Norton, Robert L. Kinematics and dynamics of machinery. McGraw-Hill Higher Education, 2011.*

Reference Books

3. *Ghosh, Amitabha, and Asok K. Mallik.Theory of mechanisms and machines.Affiliated East-West Press Private Limited, 2002.*
4. *Rattan, Sarjit S. Theory of machines.Tata McGraw-Hill Education, 2014.*

DATA STRUCTURE	
Course Code: 23MEAI 02	
Credits: 3	
L T P : 3 0 0	
Prerequisite: NIL	

Course Objectives:

The objective of studying this course is:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures

Course Outcomes: At the end of the course, the student shall be able to:

CO1- For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.

CO2- Student will able to write searching and sorting algorithm compare their performance in term of Space and Time complexity.

CO3- For a given problem of Stacks, Queues, linked list and Tree, student will able to implement it and analyze the same to determine the time and computation complexity.

CO4- Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.

Course Objectives	COURSE LEARNING OUTCOMES			
	CO 1	CO 2	CO 3	CO 4
CO 1	√			
CO 2		√		
CO 3			√	
CO 4				√

Course Contents:

Unit 1

Introduction: Basic Terminologies: Elementary Data Organizations, Asymptotic Notations. Searching: Linear Search and Binary Search Techniques and their complexity analysis. Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort

Unit 2

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it andalgorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

Unit 3

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks, ADT queue, Types of Queues and operations. Algorithms and their analysis.

Unit-4

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis.

Unit-5

Hashing and Graph: Hashing and collision resolution. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Text Books/ Reference Books:

1. A. M. Tenenbaum, Langsam, Moshe J. Augentem, “Data Structures using C,” PHI Publication.

2. A.V. Aho, J.E. Hopcroft and T.D. Ullman, “Data Structures and Algorithms” Original edition, Addison-Wesley.

3. Ellis Horowitz & Sartaj Sahni, “Fundamentals of Data structures”.

4. https://nptel.ac.in/courses/106102064

INTRODUCTION TO ARTIFICIAL INTELLIGENCE	
Course Code: 23MEAI 03	
Pre-Requisite : NIL	
L T P : 3 0 0	
Credits: 3	

COURSE OBJECTIVES

This course aims to:

1. Understand the fundamental concepts of Artificial Intelligence (AI) and its subfields, including Machine Learning, Computer Vision, and Natural Language Processing, in the context of mechanical engineering.
2. Explore the applications of AI techniques, such as Machine Learning algorithms and Computer Vision tools, in solving mechanical engineering problems, including predictive maintenance, optimization, quality control, and automation.
3. Develop proficiency in using AI tools and technologies relevant to mechanical engineering, such as neural networks, image and video processing techniques, and natural language processing tools.
4. Gain hands-on experience in applying AI techniques to real-world mechanical engineering scenarios through case studies, projects, and practical exercises.

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to:

1. Understand the fundamental concepts of Artificial Intelligence (AI) and its subfields, including Machine Learning, Computer Vision, and Natural Language Processing, in the context of mechanical engineering.
2. Explore the applications of AI techniques, such as Machine Learning algorithms and Computer Vision tools, in solving mechanical engineering problems, including predictive maintenance, optimization, quality control, and automation.
3. Develop proficiency in using AI tools and technologies relevant to mechanical engineering, such as neural networks, image and video processing techniques, and natural language processing tools.
4. Gain hands-on experience in applying AI techniques to real-world mechanical engineering scenarios through case studies, projects, and practical exercises.
5. Understand the ethical considerations, challenges, and emerging trends related to the integration of AI in mechanical engineering, and develop an awareness of the societal impact and potential limitations of AI technologies in the field.

Course Objectives	COURSE LEARNING OUTCOMES				
	CO 1	CO 2	CO 3	CO 4	CO 5
CO 1	√				√
CO 2		√			
CO 3			√		
CO 4				√	

COURSE CONTENTS

UNIT-I : Artificial Intelligence Overview

Eras of Computing, Types and main focus of AI, Introduction to Machine Learning (ML) and its types, Neural Networks, Natural Language Processing (NLP) and its processes, Use Cases of AI: Computer Vision tools and their use cases, Introduction to Cognitive Computing

UNIT-II: Machine Learning in Mechanical

Introduction to Machine Learning algorithms and techniques, Supervised, Unsupervised, and Reinforcement Learning, Machine Learning applications in Mechanical Engineering, Predictive maintenance using ML in Mechanical Systems. Optimization and control using ML techniques, Case studies and examples of ML in Mechanical Engineering

UNIT-III: Computer Vision in Mechanical Engineering

Introduction to Computer Vision and its applications in Mechanical Engineering, Image and video processing techniques for Mechanical Systems, Object detection and recognition in Mechanical Engineering, Quality control and inspection using Computer Vision, Industrial automation and robotics applications of Computer Vision, Case studies and examples of Computer Vision in Mechanical Engineering.

UNIT-IV: Natural Language Processing in Mechanical Engineering

Introduction to Natural Language Processing and its applications in Mechanical Engineering, Text analysis and processing for Mechanical Systems, Automated documentation and reporting using NLP, Voice-enabled interfaces and speech recognition in Mechanical Engineering, Case studies and examples of NLP in Mechanical Engineering.

UNIT-V: AI Integration in Mechanical Engineering

Integration of AI techniques in Mechanical Systems, Sensor fusion and data integration for AI-enabled Mechanical Systems, AI-driven decision-making and control in Mechanical Engineering, AI-based optimization and design in Mechanical Engineering, Ethical considerations and challenges of AI integration in Mechanical Engineering, Emerging trends and future directions of AI in Mechanical Engineering

TEXT/REFERENCE BOOKS

- "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
- "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy
- "Computer Vision: Algorithms and Applications" by Richard Szeliski
- "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper
- "Introduction to Robotics: Mechanics and Control" by John J. Craig
- "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- "Pattern Recognition and Machine Learning" by Christopher M. Bishop
- "Convolutional Neural Networks for Visual Recognition" by Fei-Fei Li, Andrej Karpathy, and Justin Johnson
- "Speech and Language Processing" by Daniel Jurafsky and James H. Martin
- "Robotics: Modelling, Planning, and Control" by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo

SOFT COMPUTING	
Course Code: 23MEAI 04	
Pre-Requisite : NIL	
L T P : 3 0 0	
Credits: 3	

COURSE OBJECTIVES:

On successful complete of this course, the students should be able to:

1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
2. To implement soft computing-based solutions for real-world problems.
3. To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.

COURSE LEARNING OUTCOMES:

At the end of the course, the student shall be able to:

CO1- identify and describe soft computing techniques and their roles in building intelligent Machines.

CO2- apply fuzzy logic and reasoning to handle uncertainty in engineering problems.

CO3- apply genetic algorithms to solve combinatorial optimization problems.

CO4- evaluate and compare solutions by various soft computing approaches for a given problem.

Course Objectives	COURSE LEARNING OUTCOMES			
	CO 1	CO 2	CO 3	CO 4
CO 1	√			
CO 2		√		√
CO 3			√	

Course Contents:

Unit 1

Introduction to Soft Computing: Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics.

Unit 2

Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy numbers, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making, Fuzziness of fuzzy sets, Fuzzy propositions.

Unit 3

Neural Networks: Basic characteristics of artificial neural networks, Perceptron model, Multilayer Perceptron model, Adaptive Networks, Feed forward Networks, Supervised Learning.

Unit 4

Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks.

Unit 5

Genetic Algorithms: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning, Machine Learning Approach to Knowledge Acquisition.

Text Books/ Reference Books:

- George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", PHI Learning Private Limited.
- Satish Kumar, "Neural Networks: A classroom approach" Tata McGraw Hill Education 1st Edition 2005
- Haykin S., "Neural Networks-A Comprehensive Foundations", Pearson Education 2nd Edition.
- Anderson J.A., "An Introduction to Neural Networks", MIT Press.
- M.Ganesh, "Introduction to Fuzzy sets and Fuzzy Logic" PHI.
- N.P. Padhy and S P Simon, "Soft Computing with MATLAB Programming", Oxford University Press 2015.
- NPTEL course Introduction to Soft Computing, IIT Kharagpur, Prof. Debasis Samanta https://nptel.ac.in/courses/106105173

Robot Dynamics and Control	
Course Code: 23MEAI 05	
Credits: 3	
L T P : 0 0 3	
Prerequisite: Kinematics of Robotics	

COURSE OBJECTIVES (CO)

- To acquaint students with the fundamentals of robotic dynamics
- To familiarize students with dynamics of the open chains
- To acquaint students with the process of trajectory generation
- To make students understand the motion planning in robots
- To familiarize students with control of robotic system

COURSE LEARNING OUTCOMES (CLO)

After completion of course, students would be able to demonstrate:

- The understanding of mechanics of rigid body
- The understanding of open link dynamics
- The planning for trajectory generation and motion
- The process of controlling robotics system

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	CLO1	CLO2	CLO3	CLO4
CO1				
CO2				
CO3				
CO4				
CO5				

COURSE CONTENTS

Unit-I: Configuration Space - Degrees of Freedom of a Rigid Body- Degrees of Freedom of a Robot- Robot Joints - Grubler's Formula - Configuration Space: Topology and Representation - Configuration Space Topology- Configuration Space Representation- Configuration and Velocity Constraints- Task Space and Workspace.

Unit –II: Dynamics of Open Chains- Lagrangian Formulation- Basic Concepts and Motivating Examples- General Formulation- Understanding the Mass Matrix- Lagrangian Dynamics vs. Newton–Euler Dynamics- Dynamics of a Single Rigid Body- Classical Formulation- Twist–Wrench Formulation- Dynamics in Other Frames- Newton–Euler Inverse Dynamics- Derivation-

Newton-Euler Inverse Dynamics Algorithm- Dynamic Equations in Closed Form- Forward Dynamics of Open Chains- Dynamics in the Task Space- Constrained Dynamics - Actuation, Gearing, and Friction- DC Motors and Gearing- Apparent Inertia- Newton–Euler Inverse Dynamics Algorithm Accounting for Motor Inertias and Gearing- Friction- Joint and Link Flexibility

Unit –III: Trajectory Generation – Definitions- Point-to-Point Trajectories- Straight-Line Paths-Time Scaling a Straight-Line Path- Polynomial Via Point Trajectories- Time-Optimal Time Scaling- The $(s, \dot{s})$ Phase Plane- The Time-Scaling Algorithm- A Variation on the Time-Scaling Algorithm- Assumptions and Caveats

Unit –IV: Motion Planning- Overview of Motion Planning- Types of Motion Planning Problems-Properties of Motion Planners- Motion Planning Methods- Foundations- Configuration Space Obstacles- Distance to Obstacles and Collision Detection- Graphs and Trees- Graph Search-Complete Path Planners - Grid Methods- Multi-Resolution Grid Representation- Grid Methods with Motion Constraints - Nonlinear Optimization – Smoothing

Unit -V: Robot Control- Control System Overview- Error Dynamics- Error Response- Linear Error Dynamics- Motion Control with Velocity Inputs- Motion Control of a Single Joint- Motion Control of a Multi-joint Robot- Task-Space Motion Control- Motion Control with Torque or Force Inputs- Motion Control of a Single Joint- Motion Control of a Multi-joint Robot- Task-Space Motion Control- Force Control- Hybrid Motion–Force Control- Natural and Artificial Constraints- A Hybrid Motion–Force Controller- Impedance Control- Impedance-Control Algorithm- Admittance-Control Algorithm- Low-Level Joint Force/Torque Control- Software

TEXT BOOKS

1. Modern Robotics: Mechanics, Planning, and Control, Kevin M. Lynch and Frank C. Park, Cambridge University Press, 2017

DISCRETE STRUCTURES	
Course Code: 23MEAI 06	
Pre-Requisite : NIL	
L T P : 3 1 0	
Credits: 4	

COURSE OBJECTIVES

1. To learn various ways for describing sets, i.e., logic and proofs.
2. To illustrate by examples the basic terminology of sets, relation and function.
3. To understand and learn various methods for computing the size of sets.
4. To illustrate by example basic terminology of graph theory and model problems in computer science using graphs.
5. To teach the basic constructs of algebraic systems and number theory.

COURSE LEARNING OUTCOMES (CLO)

The syllabus adheres to all Bloom's Taxonomy Levels and has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Model logic statements arising in algorithm correctness and real-life situations and manipulate them using the formal methods of propositional and predicate logic.
2. Relate the ideas of mathematical induction to recursion and recursively defined structures.
3. Identify and model the relation between sets.
4. Demonstrate in practical applications the use of basic counting principles.
5. Establish and solve recurrence relations that arise in counting problems including the problem of determining the time complexity of recursively defined algorithms
6. Deduce properties that establish particular graphs as Planar, Eulerian, and Hamiltonian.
7. Formalizes the sets with the binary operations.
8. Understand the application of number theory in cryptography.

COURSE LEARNING OUTCOMES (CLO)-COURSE OBJECTIVES (CO) MAPPING

	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6	CLO7	CLO8
CO1	✓	✓						
CO2			✓					
CO3				✓	✓			
CO4						✓		
CO5							✓	✓

COURSE CONTENTS

UNIT-I: INRODUCTION TO LOGIC

Propositional Logic, Applications of Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Introduction to Proofs, Proof Methods and Strategy, Mathematical Induction:

examples, strong Induction, well ordering principle, invariants.

UNIT-II: BASIC MATHEMATICAL STRUCTURES

Sets, definition, types of sets, Venn Diagram, using set notation with Quantifier, Set Operations, Set Identities, Russell's paradox, Halting Problem (infinity and Diagonalization)

Functions, definition and properties, types of functions, comparing infinite sets using functions, countable and countably infinite sets, Continuum hypothesis.

Relation : equivalence relations and partitions of a set, partial order relations, posets, Hasse diagram, chains, anti-chains, topological sort, applications to (parallel) task scheduling, lattices.

UNIT-III: COUNTING TECHNIQUES

Basic Counting Techniques: product and sum principles, the bijection principle, division rule, double counting, Handshake lemma, the binomial theorem, Pascal's triangle, permutations and combinations with and without repetitions.

Advanced counting Techniques: Sequences : Sum of sequences and product of sequences, estimating factorials, recurrence relations, Solving recurrence relations, Solving recurrence relations via generating functions, Applications of generating functions, Principle of Inclusion Exclusion and its applications, Counting techniques: Pigeon-hole principle (PHP), its variants and its applications,

Applications and Extensions of PHP to the coloring game, a glimpse of Ramsey theory.

UNIT-IV: GRAPH THEORY

Basic terminology, Konigsberg bridge problem, Eulerian graphs, Hamiltonian Graphs, Bipartite graphs and a characterization, Planar Graphs , Representation of graphs, Graph isomorphism and Homomorphism, Graph Coloring Subgraphs, cliques and independent sets, large bipartite subgraphs, connected components, cut edges.

UNIT-V: ALGEBRAIC SYSTEMS

Algebraic systems: Semigroup, Monoid, Groups, Abelian group, Cyclic Group, Subgroup, order of a group, order of subgroups of a group, Lagrange's theorem, group isomorphism and homomorphism.

TEXT BOOKS

1. Kenneth H.Rosen, Discrete Mathematics and its Application, Fifth edition, Tata McGraw-Hill Publishing company PVT .Ltd., New Delhi, 2003
2. C.L.Liu, Elements of Discrete Mathematics, second edition 1985, McGraw-Hill Book Company. Reprinted 2000
3. Discrete Mathematics, N L Biggs.
4. Introduction to Graph Theory, 2nd Edition, by Douglas B West. Eastern Economy Edition published by PHI Learning Pvt Ltd.

REFERENCE BOOKS

1. Bondy J. A., Murty U. S. R., Graph Theroy, Springer, 2013.
2. Tremblay J. P. and Manohar R., "Discrete Mathematical Structures with applications to Computer Science", Tata Mc Graw Hill Publishing Co., 2000

DATABASE MANAGEMENT SYSTEM	
Course Code: 23MEAI 07	
Pre-Requisite : NIL	
L T P : 3 0 0	
Credits: 3	

COURSE OBJECTIVES:

At the end of this course the student should be able to:

1. Understand the fundamentals of Database Management Systems (DBMS), including its structure, advantages, and disadvantages.
2. Familiarize with different data models such as the Data, Network, Hierarchical, and Relational models, and their characteristics.
3. Gain knowledge of entity-relationship (E-R) modeling, including entities, attributes, relationships, and constraints.
4. Learn about the Relational Model and its features, integrity constraints, logical database design, and relational algebra and calculus operations.
5. Explore the concept of normalization in database design, including data redundancy, functional dependencies, and normalization forms.

COURSE LEARNING OUTCOME:

1. Identify and analyze the structure, advantages, and disadvantages of Database Management Systems (DBMS).
2. Apply different data models, including the Data, Network, Hierarchical, and Relational models, to represent and manage data effectively.
3. Design entity-relationship (E-R) models, considering entities, attributes, relationships, and constraints, and transform them into relational schemas.
4. Utilize the Relational Model to design and implement logical database structures, enforce integrity constraints, and perform relational algebra and calculus operations.
5. Evaluate and apply normalization techniques to eliminate data redundancy and ensure data integrity in database designs.

COURSE LEARNING OUTCOMES (CLO)-COURSE OBJECTIVES (CO) MAPPING

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	CLO1	CLO2	CLO3	CLO4
CO1				
CO2				
CO3				
CO4				
CO5				

UNIT - I INTRODUCTION 9

DBMS, Structure Advantages & disadvantages, Models: -Data, Network, Hierarchical, Relational Model, Levels of abstraction, Data Independence, Instances and schemes, Data independence Application Programmers & Data Base administrators – their function, Entity Relationship Model: Entities, Attributes and Entity Sets, Relation and Relationships sets, mapping and participation constraints, Aggregation, Specialization and Generalization.

UNIT - II E-R MODEL 9

Relational Model: Features, Integrity constraints over relations, Enforcing Data Integrity, Integrity Constraints, Relational Data, Logical Data Base Design, E-R diagram Symbols, Reduction of E-R Diagrams to relations, Keys. Relational Algebra and Relational Calculus, Operations on Relational Algebra, Operations on Relational Calculus.

UNIT - III NORMALIZATION 9

Database Design, Data Redundancy, Introduction to Schema Refinement, Functional Dependencies, Normal Forms

UNIT - IV SQL 9

Structured Query Language: Basic SQL Queries, Nested Queries, Aggregate operator, Null Values, implementation of Various Relational Algebra operations, Embedded SQL

UNIT - V TRANSACTIONS & RECOVERY 9

Transaction management: ACID Properties, Transaction states, Concurrency control: Concurrency Control –Overview, Concurrency control problems, Locks, Locking Protocols, Deadlocks, Serializability, Recovery System: Types of Failures, Recovery Techniques.

Text Books:

1."Database System Concepts" by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan

2."Database Management Systems" by Raghu Ramakrishnan and Johannes Gehrke

3."Database Systems: The Complete Book" by Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom.

Reference Books:

1."Database Management Systems" by Ramakrishnan and Gehrke

2."SQL Cookbook" by Anthony Molinaro

3."Database Systems: Design, Implementation, and Management" by Carlos Coronel, Steven Morris, and Peter Rob

4."Database Design and Relational Theory: Normal Forms and All That Jazz" by C.J. Date

PROGRAMMABLE LOGIC CONTROL

Course Code:23MEPE13	
Credits: 3	
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1.Describe the purpose of each of the major PLC components

2.Identify types of signals used by PLC and discuss how they are handled

COURSE LEARNING OUTCOMES (CLO)

At the end of the course students will be able to,

1. Students will be able to describe typical components of a Programmable Logic Controller.
2. Students will be able to explain the basic concepts of a Programmable Logic Controller
3. Students will be able to state basic PLC terminology and their meanings.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE LEARNING OUTCOME / COURSE OBJECTIVES	CLO 01	CLO 02	CLO 03
CO 01	✓		
CO02		✓	✓

Unit I

Introduction of PLC, Parts of PLC, Principles of operation, PLC sizes, PLC. Hardware components: I/O section, Analog I/O section, Analog I/O modules, digital I/O modules

Unit II

CPU

Processor memory module, Programming devices, Diagnostics of PLCs with Computers, PLC programming: Simple instructions Programming, EXAMINE ON and EXAMINE OFF instructions

Unit III

Electromagnetic control relays, Motor starters, Manually operated switches, Mechanically operated and Proximity switches, Output control devices, Latching relays, PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram, Timer instructions, ON DELAY timer and OFF DELAY timer, counter instructions, Up/Down counters. Timer and Counter applications program, control instructions, Data manipulating instructions, math instructions

Unit IV

Applications of PLC: Simple materials handling applications, Automatic control of warehouse, door, Automatic lubricating oil supplier, Conveyor belt motor control, Automatic car, washing machine, Bottle label detection, Process control application, PID control of continuous processes, Networking of PLCs.

Unit V

Controlling a robot with a PLC, PLC data move, jump functions, SKIP and MCR function, PLC arithmetic, number comparison, PLC Installation, troubleshooting and maintains.

Text Book

1. F D. Petruzella, Programmable Logic Controllers, McGraw- Hills Publications, 4 th edition, 2010.
2. Siemens, PLC Handbook.

References Book

1. W I. Fletcher, An Engineering Approach to Digital Design", Prentice Hall of India Publishers,
New Delhi, 3 rd edition, 1999.
2. C H. Roth, Fundamentals of Logic Design,, Jaico Publishing house, 4 th Edition, 1999.
3. Reis & Reis, Programmable Logic Controllers, PHI Learning Publications, 5th edition, 2002.

DEEP LEARNING PRINCIPLES AND PRACTICES	
Course Code: 23MEAI 09	
Credits: 3	
L T P : 0 0 3	
Prerequisite: Basics of Programming, Statistics, Calculus, Linear Algebra	

Course Objectives:

The objective of studying this course is to

1. Build an understanding of the fundamental concepts of Deep Learning
2. Familiarize students with the neural networks and deep learning architecture
3. Introduce the concept of Classical Supervised Tasks with Deep Learning
4. Analyze real life applications and case studies of deep learning

Course Learning Outcomes: At the end of the course, the student shall be able to:

CO1- Understand deep learning concepts

CO2- Explain Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization

CO3- Discuss Neural Network, Multilayer Perceptron, Back Propagation Learning, Unsupervised Learning with Deep Network, Auto encoders, Describe Image Denoising, Semantics, Semantic Web and related problems.

CO4- Apply Deep learning techniques to solve real world problems

COURSE LEARNING OUTCOMES (CLO)-COURSE OBJECTIVES (CO) MAPPING

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	CLO1	CLO2	CLO3	CLO4
CO1				
CO2				
CO3				
CO4				

Course Contents:

Unit 1

Introduction to Deep Learning, Bayesian Learning, Decision Surfaces

Unit 2

Linear Classifiers, Linear Machines with Hinge Loss, Optimization Techniques, Gradient Descent, Batch Optimization

Unit 3

Introduction to Neural Network, Multilayer Perceptron, Back Propagation Learning, Unsupervised Learning with Deep Network, Auto encoders

Unit 4

Convolutional Neural Network, Building blocks of CNN, Transfer Learning, Revisiting Gradient Descent, Momentum Optimizer, Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization

Unit 5

Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN etc.

Case Study of Deep Reinforcement Learning for Engineering Design: Application to Microfluidic Devices for Flow Sculpting, Integrating Deep Learning into CAD/CAE System: Case Study on Road Wheel Design Automation, Applications of Deep Learning & AI: optimize production floors, manufacturing supply chains; predict plant/unit failures, Reducing Test and Calibration Time

Text Books/ Reference Books:

1. Deep Learning, Ian Goodfellow, Yoshua Bengio and Aeron Courville, MIT Press, First Edition, 2016.
2. Deep Learning, A practitioner's approach, Adam Gibson and Josh Patterson, O'Reilly, First Edition, 2017.
3. Hands-On Learning with Scikit-Learn and Tensorflow, Aurelien Geron, O'Reilly, First Edition, 2017.
4. Deep Learning with Python, Francois Chollet, Manning Publications Co, First Edition, 2018.
5. Python Machine Learning by Example, Yuxi (Hayden) Liu, First Edition, 2017.
6. A Practical Guide to Training Restricted Boltzmann Machines, Geoffrey Hinton, 2010.
7. https://nptel.ac.in/courses/106106184
8. https://onlinecourses.nptel.ac.in/noc19_cs85/preview

Mobile Robots	
Course Code: 23MEAI 10	
Credits: 3	
L T P : 0 0 3	
Prerequisite: Fundamentals of Robotics	

COURSE OBJECTIVES (CO) :

After completing the course, the student should be able to:

1. discuss ethical problems related to practical applications of mobile robots Judgement and approach
2. To acquaint students with the fundamentals of mobile robotics
3. To familiarize students with control of mobile robots

COURSE LEARNING OUTCOMES (CLO)

After completing the course, the student should be able to:

1. explain the operational principles of (and distinctions between) various types of mobile robot architectures
2. give a detailed account of theories and algorithms for mapping and localization
3. give a detailed account of theories and algorithms for path and motion planning
4. Competence and skills
5. After completing the course, the student should be able to:
6. independently construct and deploy software for an autonomous mobile robot capable of mapping, localization, path planning, and motion planning.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES					
	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6
CO1						
CO2						
CO3						

COURSE CONTENTS

Unit-I: Introduction- Applications of Mobile Robots- Types of Mobile Robots- Automated Guided Vehicles (AGVs)- Service Robots- Cleaning and Lawn Care Robots- Social Robots- Field Robots- Inspection, Reconnaissance, Surveillance, and Exploration Robots- Mobile Robot Engineering- Mobile Robot Subsystems- Overview of the Text- Fundamentals of Wheeled Mobile Robots.

Unit –II: State Estimation- Mathematics of Pose Estimation- Pose Fixing versus Dead Reckoning- Pose Fixing- Error Propagation in Triangulation- Real Pose Fixing Systems- Dead Reckoning- Real Dead Reckoning

Systems- Sensors for State Estimation- Articulation Sensors- Ambient Field Sensors- Inertial Frames of Reference- Inertial Sensors- Inertial Navigation Systems- Introduction- Mathematics of Inertial Navigation- Errors and Aiding in Inertial Navigation- Example: Simple Odometry-Aided Attitude and Heading Reference System- Satellite Navigation Systems- Introduction- Implementation- State Measurement- Performance- Modes of Operation

Unit –III: Perception- Image Processing Operators and Algorithms- Taxonomy of Computer Vision Algorithms- High-Pass Filtering Operators- Low-Pass Operators- Matching Signals and Images- Feature Detection- Region Processing- Physics and Principles of Radiative Sensors- Radiative Sensors- Techniques for Range Sensing- Radiation- Lenses, Filters, and Mirrors- Sensors for Perception- Laser Rangefinders- Ultrasonic Rangefinders- Visible Wavelength Cameras- Mid to Far Infrared Wavelength Cameras- Radars- Aspects of Geometric and Semantic Computer Vision- Pixel Classification- Computational Stereo Vision- Obstacle Detection

Unit –IV: Localization and Mapping- Representation and Issues- Introduction- Representation- Timing and Motion Issues- Related Localization Issues- Structural Aspects -Example: Unmanned Ground Vehicle (UGV) Terrain Mapping- Visual Localization and Motion Estimation- Introduction- Aligning Signals for Localization and Motion Estimation - Matching Features for Localization and Motion Estimation- Searching for the Optimal Pose- Simultaneous Localization and Mapping- Introduction- Global Consistency in Cyclic Maps – Revisiting- EKF SLAM for Discrete Landmarks- Example: Auto surveying of Laser Reflectors

Unit –V: Motion Planning- Introduction- Introducing Path Planning- Formulation of Path Planning- Obstacle-Free Motion Planning- Representation and Search for Global Path Planning - Sequential Motion Planning- Big Ideas in Optimization and Search- Uniform Cost Sequential Planning Algorithms- Weighted Sequential Planning- Representation for Sequential Motion Planning- Real-Time Global Motion Planning: Moving in Unknown and Dynamic Environments- Introduction- Depth-Limited Approaches- Anytime Approaches- Plan Repair Approach: D* Algorithm- Hierarchical Planning

TEXT BOOKS

1. Mobile Robotics- Mathematics, Models, and Methods by Alonzo Kelly, Cambridge University Press- 2013

REFERENCE BOOKS

1. Springer Handbook of Robotics
2. Robotics, Vision, and Control: Fundamental Algorithms in MATLAB by Peter Corke
3. Probabilistic Robotics by Sebastian Thrun, Wolfram Burgard and Dieter Fox
4. Introduction to Robotics: Mechanics and Control (3rd Edition) by J.J. Craig
5. Introduction to autonomous mobile robots by Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza
6. Planning Algorithms by Steven M. LaValle, Cambridge Press

AI IN AUTONOMOUS VEHICLES	
Course Code: 23MEAI 11	
Credits: 3	
L T P : 3 0 0	
Prerequisite: 1. Basic knowledge of computer science and programming 2. Familiarity with algorithms and data structures 3. Understanding of machine learning concepts (e.g., supervised learning, unsupervised learning)	

Course Objectives:

By the end of the course, students will be able to:

1. To provide students with a comprehensive understanding of autonomous vehicles, including their history, evolution, and levels of autonomy.
2. To introduce students to the sensor technologies and perception algorithms used in autonomous vehicles for object detection and tracking.
3. To familiarize students with machine learning techniques, particularly in the context of perception tasks in autonomous driving.
4. To explore decision-making architectures and reinforcement learning methods for autonomous vehicles' behavior planning and trajectory generation.

Course Learning Outcome:

The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of course, students would be able to:

1. Identify the historical background and evolution of autonomous vehicles and describe the levels of autonomy and their characteristics.
2. Understand the sensor technologies used in autonomous vehicles for perception, including cameras, lidar, and radar, and analyze data reprocessing and filtering techniques.
3. Apply machine learning algorithms, including supervised and deep learning techniques, for perception tasks in autonomous vehicles.
4. Analyze decision-making architectures in autonomous vehicles and apply behavior planning and trajectory generation techniques.
5. Design control systems for autonomous vehicles using principles such as PID control, model predictive control, and advanced control techniques.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs):

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES

	CLO1	CLO2	CLO3	CLO4
CO1				
CO2				
CO3				
CO4				
CO5				

Course Content:

Unit-1

Introduction to Autonomous Vehicles-History and evolution of autonomous vehicles, Levels of autonomy and their characteristics, Challenges and opportunities in autonomous driving. Perception for Autonomous Vehicles- Sensor technologies for perception (e.g., cameras, lidar, radar), Data reprocessing and filtering, Object detection and tracking algorithms.

Unit-2

Machine Learning for Perception: Introduction to machine learning in autonomous vehicles, Supervised learning algorithms for perception tasks, Deep learning techniques for computer vision. Decision-Making Systems-Decision-making architectures in autonomous vehicles, Behavior planning and trajectory generation, Reinforcement learning for decision-making.

Unit-3

Control Systems for Autonomous Vehicles: Vehicle dynamics and control principles, PID control and model predictive control, Advanced control techniques for autonomous driving. Simulations and Testing-Simulation environments for autonomous vehicles, Testing and validation of AI systems, Safety considerations and failure modes.

Unit-4

Localization and Mapping: Techniques for simultaneous localization and mapping (SLAM), Sensor fusion and state estimation, Map representation and update algorithms. Human-Machine Interaction- Human factors in autonomous driving, User interfaces and driver assistance systems, Ethical considerations in human-machine interaction.

Unit-5

Integration and System Architecture: Integration of AI systems in autonomous vehicles, Communication protocols and network architecture, Hardware considerations for AI-enabled vehicles. Industry applications and challenges, Emerging trends in autonomous driving. Ethical dilemmas in autonomous driving, Legal and regulatory frameworks, Privacy and security concerns.

Textbooks:

1. "Autonomous Vehicles: Intelligent Transport Systems and Smart Technologies" by Kara A. Dickinson
2. "Perception and Decision-Making in Autonomous Vehicles" by Ching-Yao Chan and Behrooz Kalantari
3. "Control Systems for Autonomous Vehicles: Design and Applications" by Kripa K. Venkat and Bin Li
4. "Localization and Mapping for Autonomous Vehicles" by José J. Guerrero and Miguel A. Sotelo
5. "Autonomous Driving: Technical, Legal and Social Aspects" by Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner.

Reference Books:

1. "Autonomous Vehicles: From Concept to Reality" by Wolfgang Gessner
2. "Sensor Fusion and Object Tracking for Autonomous Driving" by Reinhard Koch and Alexander Zelinsky
3. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy
4. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto
5. "Computer Vision: Algorithms and Applications" by Richard Szeliski

MACHINE LEARNING	
Course Code: 23MEAI 12	
Credits: 3	
L T P : 3 0 0	
Prerequisite: 1. Basic knowledge of computer science and programming 2. Familiarity with algorithms and data structures 3. Understanding of machine learning concepts (e.g., supervised learning, unsupervised learning)	

Pre- Requisite: Artificial Intelligence

Course Objectives: the objective of this course for the student is:

1. To learn and understand the features of machine learning to apply on real world problems and other applications.
2. To design and analyze various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
3. Explore supervised and unsupervised learning paradigms of machine learning.
4. To explore Deep learning technique and various feature extraction strategies.

Course Learning Outcomes: At the end of the course, the student shall be able to:

CO1- Extract features that can be used for a particular machine learning approach in various applications and real world scenarios.

CO2- To compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach.

CO3- To mathematically analyze various machine learning approaches and paradigms

CO4- To understand deep learning algorithms and their strategies.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs):

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	CLO1	CLO2	CLO3	CLO4
CO1				
CO2				
CO3				
CO4				

Course Contents:

Unit 1

Supervised Learning (Regression/Classification) Basic methods: Distance-based methods, Nearest-Neighbors, Decision Trees, Naive Bayes Linear models: Linear Regression, Logistic Regression, Generalized Linear Models Support Vector Machines, Nonlinearity and Kernel Methods Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

Unit 2

Clustering: K-means/Kernel K-means Dimensionality Reduction: PCA and kernel PCA Matrix Factorization and Matrix Completion Generative Models (mixture models and latent factor models)

Unit 3

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

Unit 4

Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning: perceptrons, Feed forward neural network, back-propagation, gradient descent, Feature Representation Learning

Unit 5

Scalable Machine Learning (Online and Distributed Learning), Introduction to Bayesian Learning and Inference, Recent trends in various learning techniques of machine learning and classification methods.

Text Books/ Reference Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007

AI in Design Optimization for Mechanical Engineering

Course Code: 23MEAI 13	
Credits: 3	
L T P : 3 0 0	
Prerequisite: 1. Basic knowledge of computer science and programming 2. Fundamental of Artificial Intelligence. 3. Sensor Fusion. 4. Control System and Robotics	

Course Objectives:

1. Understand the significance of design optimization in mechanical system design and the fundamentals of optimization, including objectives, constraints, variables, and design space.
2. Learn about unconstrained optimization methods, such as gradient-based and derivative-free approaches, and apply them to optimize mechanical designs.
3. Explore constrained optimization methods, including penalty function, Lagrange multipliers, and Karush-Kuhn-Tucker conditions, for optimization problems with constraints.
4. Gain knowledge of experimental design and statistical analysis techniques, such as factorial designs and response surface methodology, for design optimization using Design of Experiments (DoE).
5. Understand and apply AI techniques, such as Genetic Algorithms and Evolutionary Optimization, in design optimization problems and explore their advantages and limitations.

Course Learning Outcomes:

1. Apply optimization techniques to mechanical system design and solve design optimization problems considering objectives, constraints, and design space.
2. Compare and contrast different unconstrained optimization methods, including gradient-based and derivative-free approaches, and select the appropriate method for a given problem.
3. Utilize constrained optimization methods, such as penalty function, Lagrange multipliers, and Karush-Kuhn-Tucker conditions, to handle design optimization problems with constraints effectively.
4. Design and conduct experiments using factorial designs and response surface methodology, and analyze the results for optimization using Design of Experiments (DoE).
5. Apply AI techniques, specifically Genetic Algorithms and Evolutionary Optimization, to design optimization problems and evaluate their performance compared to traditional optimization methods.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs):

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content:

UNIT-1

Introduction to AI and Design Optimization: Design optimization and its significance in mechanical system design, Fundamentals of Optimization: Basic concepts of optimization: objectives, constraints, variables, and design space.

UNIT-2

Unconstrained optimization methods: gradient-based and derivative-free approaches. Constrained optimization methods: penalty function, Lagrange multipliers, and Karush-Kuhn-Tucker conditions.

UNIT-3

Introduction to experimental design and statistical analysis: Factorial designs, response surface methodology, and optimization using DoE. Design optimization using AI techniques in DoE. Genetic Algorithms and Evolutionary Optimization.

UNIT-4

Multi-objective Optimization: Introduction to multi-objective optimization problems, Pareto dominance, Pareto fronts, and Pareto-based optimization methods, Multi-objective evolutionary algorithms: NSGA-II, SPEA2, and MOEA/D.

UNIT-5

Real-world Applications of AI in Design Optimization: Case studies and examples of AI applications in mechanical engineering design, Optimization of mechanical components, structures, and systems using AI techniques, Integration of AI tools with commercial design software. Implementation and Hands-on Projects.

Text-Books/ Reference Books:

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig - This comprehensive book covers various aspects of AI, including optimization algorithms, and provides a solid foundation for understanding AI techniques.
2. "Introduction to Optimization" by Pablo Pedregal - This book offers a comprehensive introduction to optimization methods, including unconstrained and constrained optimization techniques, which are essential for design optimization.
3. "Design Optimization of Fluid Machinery: Applying Computational Fluid Dynamics and Artificial Intelligence Principles" by A.E. Kabeel and D.A. Abdulrahman - This book specifically focuses on the design optimization of fluid machinery and combines computational fluid dynamics (CFD) with AI principles, providing practical insights into AI techniques in design optimization.
4. "Experimental Design for Formulation" by Anthony C. Davison and David V. Hinkley - This book covers experimental design and statistical analysis, including factorial designs and response surface methodology, which are important for understanding optimization using Design of Experiments (DoE).
5. "Multi-Objective Optimization Using Evolutionary Algorithms" by Kalyanmoy Deb - This book provides a comprehensive overview of multi-objective optimization techniques and algorithms, including NSGA-II, SPEA2, and MOEA/D, which are commonly used in design optimization.
6. "Artificial Intelligence in Design" by J.S. Gero - This book focuses on the application of AI in design processes and provides case studies and examples of AI applications in various engineering disciplines, including mechanical engineering.
7. "Optimization Concepts and Applications in Engineering" by Ashok D. Belegundu and Tirupathi R. Chandrupatla - This book covers optimization concepts and applications in engineering, including the integration of AI tools with commercial design software, which is relevant to real-world applications of AI in design optimization.

COMPUTER VISION IN MECHANICAL ENGINEERING	
Course Code: 23MEAI 14	
Credits: 3	
L T P : 0 0 3	
Prerequisite: 1. Image Processing 2. machine Learning	

Course Objectives:

1. Develop an understanding of computer vision principles and its applications in mechanical engineering.
2. Learn the fundamentals of image processing, including filtering, enhancement, restoration, and color image processing.
3. Explore various techniques for image feature extraction and description, such as edge detection, corner detection, SIFT, SURF, and HOG.

Course Learning Outcomes:

1. Apply image processing techniques, including filtering, enhancement, and restoration, to preprocess images in mechanical engineering applications.
2. Utilize different image feature extraction and description methods, such as edge detection, corner detection, SIFT, SURF, and HOG, for feature analysis and recognition.
3. Perform image segmentation using thresholding, edge-based segmentation, region-based segmentation, watershed segmentation, and graph cuts to separate objects or regions of interest.
4. Implement object detection and recognition techniques, including template matching, Haar cascades, feature-based detection (RANSAC, Hough Transform), and deep learning-based detection (YOLO, SSD, Faster R-CNN).

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs):

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES			
	CLO1	CLO2	CLO3	CLO4
CO1				
CO2				
CO3				

Course Content:

UNIT-1

Overview of computer vision and its applications in mechanical engineering. Image acquisition and representation. Image processing fundamentals: filtering, enhancement, and restoration. Color spaces and color image processing.

UNIT-2

Image Feature Extraction and Description: Edge detection techniques: Sobel, Canny, and Laplacian of Gaussian. Corner detection: Harris corner detector. Scale-invariant feature transform (SIFT). Speeded-Up Robust Features (SURF). Histogram of Oriented Gradients (HOG). Image Segmentation: Thresholding techniques: global and adaptive thresholding. Edge-based segmentation: Canny edge detection and edge linking. Region-based segmentation: region growing and split-and-merge algorithms. Watershed segmentation. Graph cuts and level sets for segmentation.

UNIT-3

Object Detection and Recognition: Template matching techniques. Haar cascades and Viola-Jones algorithm. Feature-based object detection: RANSAC, Hough Transform. Introduction to deep learning-based object detection: YOLO, SSD, Faster R-CNN. Image Registration and Alignment: Image transformation and geometric correction. Image alignment techniques: feature-based and intensity-based methods. Applications of image registration in mechanical engineering.

UNIT-4

3D Vision and Depth Estimation: Stereo vision and disparity estimation. Structure from motion (SfM). Depth estimation using depth sensors: time-of-flight and structured light. Object Tracking: Motion estimation and optical flow. Kalman filters and particle filters for object tracking. Multiple object tracking.

UNIT-5

Applications of Computer Vision in Mechanical Engineering: Quality control and inspection in manufacturing processes. Robotics and automation: visual perception and manipulation. Augmented reality (AR) and virtual reality (VR) in mechanical engineering. Computer vision for autonomous vehicles and drones. Deep learning-based computer vision techniques. Integration of computer vision with robotics. Case studies and real-world applications.

Text Books/Reference Books:

1. "Computer Vision: Algorithms and Applications" by Richard Szeliski
2. "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods
3. "Computer Vision: Models, Learning, and Inference" by Simon J.D. Prince
4. "Computer Vision: A Modern Approach" by David A. Forsyth and Jean Ponce
5. "Image Processing, Analysis, and Machine Vision" by Milan Sonka, Vaclav Hlavac, and Roger Boyle
6. "Computer Vision: Principles, Algorithms, Applications, Learning" by E. R. Davies
7. "Introduction to Image Processing and Analysis" by John C. Russ
8. "Multiple View Geometry in Computer Vision" by Richard Hartley and Andrew Zisserman
9. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
10. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

COGNITIVE LEARNING IN AI	
Course Code: 23MEAI 15	
Credits: 3	
L T P : 0 0 3	
Prerequisite: 1. Image Processing 2. machine Learning	

Course Objectives:

1. Understand the principles of cognitive learning and its relationship to artificial intelligence (AI).
2. Explore the historical development and key concepts in cognitive learning and compare cognitive learning approaches with traditional AI techniques.
3. Gain knowledge of cognitive psychology fundamentals, including perception, attention, memory models, problem-solving, decision-making theories, and cognitive architectures.
4. Learn about different cognitive architectures (e.g., ACT-R, Soar, CLARION) and their components, cognitive modeling techniques, neural networks, deep learning models for cognitive tasks, and connectionist models of cognition.

Course Learning Outcomes:

1. Apply the principles of cognitive learning to understand and analyze AI systems from a cognitive perspective.
2. Compare and contrast cognitive learning approaches with traditional AI techniques, identifying their strengths and limitations.
3. Analyze and evaluate cognitive psychology models, including perception, attention, memory, problem-solving, and decision-making theories, in the context of AI.
4. Evaluate different cognitive architectures and modeling techniques, such as neural networks, deep learning, symbolic AI, and connectionist models, for cognitive tasks.
5. Understand and discuss the theories of learning, memory, and associative learning models, applying them to cognitive AI scenarios.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs):

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					

Course Content:

UNIT-1

Introduction to Cognitive Learning: Overview of cognitive science and its relation to AI, Historical development and key concepts in cognitive learning, Comparison of cognitive learning approaches with traditional AI techniques, Cognitive Psychology Fundamentals. Perception, attention, and memory models, Problem-solving and decision-making theories, Cognitive Architectures.

UNIT-2

Overview of cognitive architectures (e.g., ACT-R, Soar, CLARION): Structure and components of cognitive architectures, Cognitive modeling techniques and their applications, neural networks and their biological inspiration and Deep Learning models for cognitive tasks (e.g., image recognition, natural language processing), Connectionist models of cognition, Symbolic AI and Cognitive Reasoning.

UNIT-3

Symbolic representation and reasoning techniques, Rule-based systems and expert systems, Cognitive modeling using symbolic AI approaches, Learning and Memory, Theories of learning and memory, Associative learning models (e.g., classical conditioning, reinforcement learning), Cognitive models of long-term memory, Language Processing and Understanding. Syntax, semantics, and pragmatics in cognitive AI, Language generation and dialogue systems, Perception and Attention.

UNIT-4

Computational models of visual perception, Attention mechanisms in cognitive systems, Object recognition and scene understanding, Problem Solving and Decision Making, Problem-solving strategies and algorithms, Decision-making models in cognitive AI, Heuristics and biases in decision making, Cognitive Robotics and Embodied Cognition.

UNIT-5

Cognitive architectures in robotics, Embodied cognition and its implications for AI, Human-robot interaction and collaboration, Ethical and Social Implications of Cognitive AI, Ethical considerations in cognitive AI development, Cognitive biases and fairness issues, Impact of cognitive AI on society, privacy, and employment, Future Directions and Applications, Emerging applications of cognitive AI.

Textbooks:

- "Cognitive Science: An Introduction to the Study of Mind" by Jay D. Bolter and Richard Grusin
- "Cognitive Architecture: Designing for How We Respond to the Built Environment" by Ann Sussman and Justin B. Hollander
- "Symbolic and Neural Learning Algorithms: Foundations and Applications" by Gurney, J., Hussain, A., and Soltoggio, A.
- "Cognitive Robotics" by José L. Pons and Enrique Vidal.

NATURAL LANGUAGE PROCESSING	
Course Code: 23MEAI 16	
Credits: 3	
L T P : 0 0 3	
Prerequisite: 1. Image Processing 2. machine Learning	

Course Objectives:

1. Define the scope of Natural Language Processing (NLP) and its relevance in engineering applications.
2. Explore the historical development of NLP and its current applications in various domains.
3. Identify the challenges and limitations of NLP in engineering applications.
4. Learn text processing and preprocessing techniques, including tokenization, stemming, lemmatization, stop word removal, and punctuation handling.

Course Learning Outcomes:

1. Define the scope of NLP and its relevance in engineering applications, demonstrating an understanding of the capabilities and limitations of NLP techniques.
2. Evaluate and analyze the historical development of NLP and its applications in various domains, recognizing the evolution and impact of NLP technologies.
3. Identify and overcome the challenges and limitations of NLP in engineering applications, considering the unique requirements and constraints of the field.
4. Apply text processing and preprocessing techniques, such as tokenization, stemming, lemmatization, stop word removal, and punctuation handling, to preprocess text data for NLP tasks.
5. Handle special characters and numerical data in text effectively for engineering-specific NLP tasks.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs):

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES				
	CLO1	CLO2	CLO3	CLO4	CLO5
CO1					
CO2					
CO3					
CO4					

UNIT-1

Definition and scope of NLP. Historical development and current applications in various domains. Challenges and limitations of NLP in engineering applications. Text Processing and Preprocessing:Tokenization, stemming, and lemmatization. Stop word removal and punctuation handling. Handling special characters and numerical data in text.

UNIT-2

Text Classification and Sentiment Analysis: Supervised learning algorithms for text classification. Feature extraction techniques, including bag-of-words and word embeddings. Sentiment analysis and opinion mining for mechanical engineering reviews and feedback. Named Entity Recognition (NER) and Entity Linking: Approaches to identifying and extracting named entities from text. Entity linking and disambiguation in the context of mechanical engineering domain.

UNIT-3

Topic Modeling: Latent Semantic Analysis (LSA) and Latent Dirichlet Allocation (LDA) for topic modeling. Applications of topic modeling in engineering literature analysis and knowledge discovery. Word Embeddings and Word2Vec: Distributed representations of words and word embeddings. Training and using Word2Vec models for mechanical engineering-specific text data.

UNIT-4

Text Summarization and Text Generation: Extractive and abstractive text summarization techniques. Sequence-to-sequence models for text generation in mechanical engineering reports and documentation.

UNIT-5

Information Extraction and Relation Extraction: Techniques for extracting structured information from unstructured text. Relation extraction for identifying relationships between entities in mechanical engineering documents.

Text Books/ Reference Books:

1. "Speech and Language Processing" by Daniel Jurafsky and James H. Martin.
2. "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper.
3. "Foundations of Statistical Natural Language Processing" by Christopher D. Manning and Hinrich Schütze.
4. "Text Mining: Applications and Theory" by Michael W. Berry and Jacob Kogan.
5. "Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data" by Dipanjan Sarkar.
6. "Applied Text Analysis with Python: Enabling Language-Aware Data Products with Machine Learning" by Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda.

Ability Enhancement Courses:

List of Skill Enhancement Courses:

i) Technical Training:

ESSENTIALS OF BLOCKCHAIN & IOT –LEVEL-I	
Course Code: 23CS0201	Continuous Evaluation: 70 Marks
Pre-Requisite : NIL	End Semester Examination:30 Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVES

1. To familiarise the students with functional/operational aspects of cryptocurrency ECOSYSTEM.
2. To understand emerging abstract models for Block chain Technology.
3. To learn various protocols of IoT.

TRAINING LEARNING OUTCOMES (TLOS) The syllabus has been prepared in accordance with National Education Policy (NEP). After the completion of training the students will be able to:
1. Understand how bitcoin and other coins work in real world.
2. Analyse the properties of Block Chain models.
3. Understand the vision of IoT and communication protocols from a global context.
4. Design portable IoT using appropriate boards.

TRAINING LEARNING OUTCOME (TLO)-TRAINING OBJECTIVE (TO) MAPPING

	TLO1	TLO2	TLO3	TLO4
TO1	✓			
TO2		✓		
TO3			✓	✓

TRAINING CONTENTS

MODULE	TRAINING CONTENT	STUDENTS ENGAGEMENT ACTIVITY
I	CONSENSUS The consensus problem, Abstract Models for BLOCKCHAIN : GARAY model, RLA Model, liveness and fairness, Proof of Stake (PoS) based Chains, Hybrid models (PoW + PoS)	Perform Mapping of coins and Blockchain Models
II	BITCOIN Bitcoin Introduction, Wallet - Blocks - Merkley Tree - hardness of mining - transaction verifiability - anonymity - forks - double spending - mathematical analysis of properties of Bitcoin.	To identify the type of wallet used in a specific application.
III	Introduction to IoT: Definition, Characteristics, Applications, Connectivity Layers, Addressing, Networking, Sensing: Sensors and Transducers, Sensor Classes, Sensor Types, Actuation: Actuator Basics, Actuator Types. Connectivity Technologies: ZigBee, 6LoWPAN, RFID, HART, NFC, Bluetooth, ISA100.11a.	To identify the types and characteristics of Sensors
IV	Introduction to Arduino: Basic Concepts of Arduino Platform, Examples of Arduino Programming, Integration of Sensors and Actuators with Arduino,	To design a simple application of LED lightning
V	HANDS ON ACTIVITY	Complete the

MODULE	TRAINING CONTENT	STUDENTS ENGAGEMENT ACTIVITY
	The students will design an application for smart irrigation system, smart healthcare system. In this activity students will identify the major components required for building a smart application and design the architecture and application accordingly.	Assigned Activity

LEARNING RESOURCES
1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016. 2. Honbo Zhou, ”The Internet of Things in the Cloud:A Middleware Perspective” –– CRC Press-2012 3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things (A Hands-On-Approach)”, VPT, 2014. 4. https://eprint.iacr.org/2014/349.pdf 5. https://eprint.iacr.org/2012/718.pdf 6. https://github.com/ElementsProject/lightning/blob/master/doc/deployable-lightning.pdf 7. https://www.hyperledger.org/use/tutorials 8. https://docs.soliditylang.org/en/latest 9. https://github.com/ethereum/wiki/wiki/White-Paper 10. http://gavwood.com/paper.pdf 11. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895 12. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING-LEVEL-II	
Course Code: 23CS0202	Continuous Evaluation: 70 Marks
Pre-Requisite : NIL	End Semester Examination:30 Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVES
1. To understand the need of AI
2. To describe basic AI algorithms (e.g., standard search algorithms).
3. To learn about one of the learning method of AI that is Machine Learning.
4. To identify potential application domains of AI and machine learning in practice.

TRAINING LEARNING OUTCOMES (TLOS): - The syllabus has been prepared in accordance with National Education Policy (NEP). After the completion of training the students will be able to:
1. Identify problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem
2. Understands the basics and need of AI and Machine learning in global view.
3. Understands, apply and evaluate the supervised learning techniques.
4. Design and implement the different applications using the concepts of AI and ML

TRAINING LEARNING OUTCOME (TLO)-TRAINING OBJECTIVE (TO) MAPPING

	TLO1	TLO2	TLO3	TLO4
TO1	⍰			
TO2		⍰		
TO3		⍰	⍰	
CO4			⍰	⍰

TRAINING CONTENTS

MODULE	TRAINING CONTENTS	STUDENTS ENGAGEMENT ACTIVITY
I	INTRODUCTION: Introduction to AI: Definitions, Historical foundations, Basic Elements of AI, Characteristics of intelligent algorithm, AI application Area.	Classification of AI Problems into AI task Domains
II	PROBLEM SOLVING: Depth-first, breadth-first search, Problem Reduction, Constraint Satisfaction , Means-End Analysis.	Solving manually constraint satisfaction problem
III	INTRODUCTION TO MACHINE LEARNING Machine Learning Basics, Need of Machine Learning, Application Domains, Basic Learning Techniques.	Identification of ML Model based on Application
IV	CLASSIFICATION PROBLEM Machine learning Algorithms for classification problem	Design decision trees
V	HANDS ON ACTIVITY : Students will apply the methods learnt to design applications for a) Constraint Satisfaction Problem b) Robot Traversal c) Classification problems like COVID Detection, Spam classification etc.	Implement the given activity.

Learning Resources

1. Introduction to Machine Learning, E. Alpaydin. MIT Press
2. Machine Learning, T.M. Mitchell, Mc-Graw Hill
3. Stuart Russell, Peter Norvig, Artificial intelligence : A Modern Approach, Prentice Hall, Fourth edition, 2020.
4. Rich and K. Knight," Artificial Intelligence", Tata McGraw Hill.

DESIGN THINKING AND AUGMENTED VIRTUAL REALITY-LEVEL- II & III	
Course Code: 23CS0301	Continuous Evaluation: 70 Marks
Prerequisite: NIL	End Semester Examination:30 Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVES (CO)
1. To recognize the importance of DT.
2. To explain the phases in the DT process.
3. To familiarize the students with the Augmented Virtual Reality Environment.
4. To establish and cultivate a broad and comprehensive understanding of this rapidly evolving and commercially viable field of Computer Science

TRAINING LEARNING OUTCOMES (TLOS) The syllabus has been prepared in accordance with National Education Policy (NEP). After the completion of training the students will be able to:
1. Understand and critically apply the concepts and methods of business processes.
2. Understand and analyze design thinking history and its various concepts.
3. Understand, analyze and create models with users collaboration to apply design thinking concepts.
4. Understand the role and importance of graphics in VR, AR and MR.
5. Understand the technical and experiential design foundation required for the implementation of immersive environments in current and future virtual, augmented and mixed reality platforms.

TRAINING LEARNING OUTCOME (TLO)-TRAINING OBJECTIVE (TO) MAPPING

	TLO1	TLO2	TLO3	TLO4	TLO5
TO1	?				
TO2		?	?		
TO3				?	
TO4					?

TRAINING CONTENTS

MODULE	TRAINING CONTENT	STUDENTS ENGAGEMENT ACTIVITY
I	INTRODUCTION TO DT Recognize the importance of Design Thinking, Identify the steps in the DT process, Recognize the steps in the empathize phase of DT, Identify the steps required to conduct an immersion activity	Product that you loved and hated activity.
II	DEFINE PHASE OF DT Conduct an immersion activity and fill up the DT question template, Recognize the steps to create personas in the define phase of DT, Recognize the steps to create problem statements in the define phase of DT, Define the problem statements in the define phase of DT.	Interview people and fill the DT Question template
III	IDEATE PAHSE OF DT Recognize the steps in the ideate phase of DT, Apply the steps in the ideate phase of DT, Recognize how doodling can help to express ideas, Recognize the importance storytelling in presenting ideas and protypes, Recognize the importance of the prototype phase in DT.	Ideate a solution for a Given problem.
IV	INTRODUCTION TO VR and AR Historical Overview, Current Trends and Future applications of Immersive Technologies, Best practices in VR, AR and Mixed Reality (MR),Case Study : Google Lens, ARCore	To study various AR and VR based existing applications.

MODULE	TRAINING CONTENT	STUDENTS ENGAGEMENT ACTIVITY
V	HANDS ON ACTIVITY This activity will help the students to identify the importance of an innovative approach : a) Discuss about a product that you like or dislike and identify what they need in a bad product to make it good. b) Design a prototype how AR and VR can be used in Education.	Designing of Solution to the Problem.

LEARNING RESOURCES
1. Hooked by Nir Eyal 2. The Art of Creative Thinking by Rod Judkins 3. Start Up nation by Dan Senor and Saul singer 4. Start with Why by Simon Sinek 5. Kelly S. Hale (Editor), Kay M. Stanney (Editor). 2014. Handbook of Virtual Environments: Design, Implementation, and Applications, Second Edition (Human Factors and Ergonomics) ISBN-13: 978-1466511842 6. Michael Madary and Thomas K. Metzinger. 2016. Real Virtuality: A Code of Ethical Conduct.Recommendations for Good Scientific Practice and the Consumers of VR-Technology. Frontiers in Robotics and AI 3, February: 1–23. http://doi.org/10.3389/frobt.2016.00003 7. Jason Jerald. 2015. The VR Book: Human-Centered Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool Publishers. http://doi.org/10.1145/2792790

BIG DATA ANALYTICS, TOOLS AND TECHNIQUES- LEVEL-III	
Course Code: 23CS0302	Continuous Evaluation: 70 Marks
Prerequisite: NIL	End Semester Examination:30 Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVES
1. To provide an overview of an exciting field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSQL MapReduce
3. To learn the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.

TRAINING LEARNING OUTCOMES (TLO)
The syllabus has been prepared in accordance with National Education Policy (NEP). After the completion of training the students will be able to:
1. Understand the vision of Big Data from a global context.
2. Understand and apply Hadoop in Market perspective of Big Data.
3. Evaluate the application of Big Data in Industrial and Commercial Building Automation, evaluating Big Data performance using MapReduce and Real-World Design Constraints.
4. Apply and analyze architecture and APIs with use of Devices, Gateways and Data Management in Big data.

TRAINING LEARNING OUTCOME (TLO)-TRAINING OBJECTIVE (TO) MAPPING

	TLO1	TLO2	TLO3	TLO4
TO1	?			
TO2		?	?	
TO3				?

TRAINING CONTENTS

MODULE	TRAINING CONTENTS	STUDENTS ENGAGEMENT ACTIVITY
I	BIG DATA Definition with Real Time Examples, How Big Data is generated with Real Time Generation, Use of Big	Real life examples illustrated with discussion on Significance of Big Data

MODULE	TRAINING CONTENTS	STUDENTS ENGAGEMENT ACTIVITY
	Data-How Industry is utilizing Big Data, Future of Big Data.	
II	HADOOP Why Hadoop? What is Hadoop? Hadoop vs RDBMS, Hadoop vs BigData	Students are trained on how to work on Hadoop
III	MAPREDUCE Theory, Data Flow (Map – Shuffle - Reduce), MapRed vs MapReduce APIs	Evaluating the application of Big Data in Industrial and Commercial Building Automation, evaluating Big Data performance using MapReduce and Real-World Design Constraints.
IV	HIVE AND PIG Architecture, Installation, Configuration, Hive vs RDBMS, Why Pig, Use case of Pig, Pig Components, Data Model.	Building and create state of the art architecture in Big Data. Hadoop, Creating projects and research activities based on Pig& Hive

LEARNING RESOURCES
• Gelman, Andrew, and Jennifer Hill. Data Analysis Using Regression and Multilevel/Hierarchical Models. 1st ed. Cambridge, UK: Cambridge University Press, 2006. ISBN: 9780521867061.
• Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin. Bayesian Data

Analysis. 2nd ed. New York, NY: Chapman & Hall, 2003. ISBN: 9781584883883
• Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data" by EMC Education Services
• Analytics: Data Science, Data Analysis and Predictive Analytics for Business" by Daniel Covington.
• Machine Learning for Big Data: Hands-On for Developers and Technical Professionals" by Jason Bell.

ELEMENTARY IT SKILLS	
Course Code: 23CS151A	Continuous Evaluation: 70 Marks
Pre-Requisite : NIL	End Semester Examination: 30 Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVE
1. To understand the need and utility of computers. 2. To learn and understand office automation tools. 3. To learn the basics of data analysis in spreadsheets.

TRAINING LEARNING OUTCOMES (TLO) **After the completion of course the students will be able to:**
1. Understand the basic components of computers. 2. Create algorithms for solving smaller problems using flowcharts. 3. Develop practical knowledge for documentation, spreadsheet and presentation. 4. Learn to organize data and make it readable. 5. Apply, clean and analyze the data without using code.

TRAINING LEARNING OUTCOME (TLO)-TRAINING OBJECTIVE (TO) MAPPING

	TLO1	TLO2	TLO3	TLO4	TLO5
TO1	✓	✓			
TO2			✓		
TO3				✓	✓

TRAINING CONTENTS

MODULE 1 FUNDMENTALS OF COMPUTERS

Session 1: Network troubleshooting in computer network using command line utilities.
Session 2: Introduction to RAPTOR tool.
Session 3: Create a flowchart to print "Hello World" in RAPTOR.
Session 4: Create a flowchart to add two numbers in RAPTOR.
Session 5: Create a flowchart to multiply two numbers in RAPTOR.
Session 6: Create a flowchart to check whether a number is even or odd in RAPTOR.

MODULE 2 INTERNETS & CYBER SECURITY

Session 1: Write a program in HTML to display “Hello World”.
Session 2: Write a program in HTML to display an Image.
Session 3: Write a program in HTML to create a Hyperlink.
Session 4: Write a program in HTML to embed an audio and video file.

MODULE 3 OFFICE AUTOMATION TOOLS

Session 1: Create a word file to illustrate the use of different Bullets and numbering.
Session 2: Create a word file and insert image and clipart.
Session 3: Create a word file to show mail merge.
Session 4: Create a new presentation with title slide, two content slides and apply a layout.
Session 5: Apply a theme to a presentation and animate text.
Session 6: Write the steps to run a slideshow and saving the presentation.

MODULE 4 MS EXCEL

Session 1: To study the components of MS-Excel spreadsheet.
Session 2: To create a spreadsheet and review the data entered.
Session 3: To create a spreadsheet and draw line, Bar and Pie chart.
Session 4: To create a spreadsheet any apply predefined functions.
Session 5: To create a spreadsheet and use macros.

MODULE 5 DATA ANALYSIS IN SPREADSHEET

Session 1: Write the steps to import Data in Excel.
Session 2: Write the steps for setting up Excel Dashboard file.
Session 3: Write the steps to create a table with raw data in excel.
Session 4: Analyze the data using following steps:

a) Formulas like SUMIF, COUNTIF, VLOOKUP
b) PIVOT Table
c) Chart

Session 5: Write the steps to build the Dashboard.

LIST OF ACTIVITIES

Activity 1: Draw a flowchart using RAPTOR to calculate the total and percentage of your own previous semester result.
Activity 2: Prepare your own resume using MS-Word.
Activity 3: Prepare an excel file to enter subject wise marks obtained in previous semester and calculate total and percentage using formulas.
Activity 4: Prepare a presentation of your University with the following contents:

- On the first slide, put the name and a photograph of your University.
- On the second page, display the features of your University.
- On the third page, put information about the library with a photograph.

- On the fourth page, put the information about Labs
- And so on.

Activity 5: Create a static web page using HTML on your course.

MODULE	TRAINING CONTENTS	STUDENTS ENGAGEMENT ACTIVITY
I	FUNDMENTALS OF COMPUTERS Introduction to computers, characteristics, components and its uses, Basics of Operating Systems, Computer Networks, trouble shooting in computer systems. Introduction to flowchart and algorithm, Study of RAPTOR tool for creating and executing flowcharts.	Flowchart creation Activity
II	INTERNET & CYBER SECURITY Introduction and use of internet, basic terminology, internet devices, and data transfer rate, introduction to basic protocols. Networking Safety Concerns like virus, worm, spam, DoS attacks etc., Networking security measures like anti-virus, firewall etc, Introduction to Cyber crime.	Activity Related to Web Browsers
III	OFFICE AUTOMATION TOOLS Create and Apply styles in the documents, insert and use images in documents, create and customize table of contents, implement mail-merge, create and use templates. MS POWERPOINT: creating, editing, formatting and sharing presentations, animations, smart chart, presentation views, slide notes, using multimedia and slide show.	Activity based on creation of interactive Presentation
IV	MS EXCEL Link data and spread sheets, review a spreadsheet, create and use macros, using predefined functions, formulas and operators, creating and setting chart and graphs, data validation, conditional formatting.	Activity related to creation of tables and apply formulas and function to answer the Queries
V	DATA ANALYSIS IN SPREADSHEET Pivot table and charts, data analysis using scenarios, goal seek and solver, vlookup. Concatenate, sumif, countif functions.	Design a Dashboard

LEARNING RESOURCES
• Reema Thareja, "Fundamentals of Computers ", oxford Publications. • Data Analytics In Excel Full Course | Data Analytics Course For Beginners | Simplilearn • Professional Office Procedure by Susan H Cooperman, Prentice Hall • Information Technology: Principles , Practices and Opportunities by James A Senn, Prentice Hall

DATA STRUCTURES USING C++	
Course Code: 23CS0401	Continuous Evaluation: 70Marks
Pre-Requisite : Basic Programming Knowledge	End Semester Examination:30 Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVE

1. To understand object oriented programming and advanced C++ concepts.
2. Be able to explain the difference between object oriented programming and procedural programming.
3. To understand the basic concepts of data structure and their implementation through C++
4. To understand basic concepts about stacks, queues, lists.
5. To understand concepts about searching and sorting techniques.
6. To learn and understand the applications of basic data structures.

TRAINING LEARNING OUTCOMES (TLO)

After the completion of training the students will be able to:

1. Prepare object-oriented design for small/medium scale problems.
2. Demonstrate the differences between traditional imperative design and object-oriented design
3. To explain class structures as fundamental, modular building blocks, to understand the role of inheritance, polymorphism, dynamic binding and generic structures in building reusable code
4. For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.
5. For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to determine the time and computation complexity.
6. For a given Search problem (Linear Search and Binary Search) student will able to implement it.
7. Design and identify how to select the appropriate data structure according to the problem.

TRAINING LEARNING OUTCOME (TLO)-TRAINING OBJECTIVE (TO) MAPPING

	TLO1	TLO2	TLO3	TLO4	TLO5	TLO6	TLO7
TO1	⍰						
TO2		⍰	⍰				
TO3				⍰			
TO4					⍰		
TO5						⍰	
TO6							⍰

TRAINING CONTENTS

MODULE	TRAINING CONTENTS	NO OF HOURS
I	INTRODUCTION TO C++ AND OBJECT ORIENTED CONCEPTS Introduction to Objects and Object Oriented Programming, Encapsulation (Information Hiding), Access Modifiers: Controlling access to a class, method, or variable (public, protected, private, package), Other Modifiers, Polymorphism: Overloading, Inheritance, Overriding Methods, Abstract Classes, Reusability, Class's Behaviors. Basics of a Typical C++ Environment, Pre-processors Directives, illustrative Simple C++ Programs. Header Files and Namespaces, library files, Constructor and Destructor.	3
II	INTRODUCTION TO DATA STRUCTURES Dynamic aspects of operations on data, Characteristics of data structures, Creation and manipulation of data structures, Operations on data structures, Types of data structures – linear and nonlinear Linked lists: types of linked lists – singly, doubly and circularly linked lists, operations on linked lists.	3

MODULE	TRAINING CONTENTS	NO OF HOURS
III	STACKS & QUEUE Stacks: Implementation of stacks– array and linked list, operations on stacks, Applications of Stacks. Queues: Implementation of queues– array and linked list, operations on queues, Types of queues – queue, double ended queue and priority queue.	3
IV	**Searching:** Linear search, Binary search and Hashing. Algorithms and data structures for sorting: Insertion Sort, Bubble sort, Selection Sort, Merge sort, Quick Sort, Heap sort.	3
V	HANDS ON ACTIVITY a) Design an application in C++ for undo operation. b) Design an application in C++ for job scheduling. c) Design an application in C++ to display the student's record. Also include the previous and next options to view the previous and next record in the list.	3

LEARNING RESOURCES
• Robert Lafore, "Turbo C++" • E.Balagurusamy,"Object Oriented programming Using C++", McGraw Hill Education • Seymour Lipschutz, "*Data Structures using C++*", McGraw Hill Education, Special Indian Edition, 2014. • Cormen, T. H. (2009). Introduction to Algorithms, 3rd Edition (The MIT Press) (3rd ed.). MIT Press. • M.A. Weiss, "Data Structres and Algorithms using C++".

ii) Soft Skill

<table>
<tr><td colspan="4">Department of Environmental Sciences</td></tr>
<tr><td colspan="4">Programme: Undergraduate program</td></tr>
<tr><td>Year/Semester</td><td>1ST/I or II</td><td>Course Category</td><td>Value Added Course (VAC)</td></tr>
<tr><td>Course Code</td><td>23VAC101/23VAC201</td><td>Course Title</td><td>Environmental Protection & Sustainable development</td></tr>
<tr><td colspan="2">Continuous Evaluation: 30</td><td colspan="2">End Semester Examination: 70</td></tr>
<tr><td colspan="2">Prerequisite: Nil</td><td>L T P : 2 0 0</td><td>Credits: 2</td></tr>
</table>

Value Added Courses:

Course Objectives (CO) - The Course is designed with the following objectives:

1. To provide a comprehensive understanding of the relationship between humans and the environment.
2. Aims to introduce students to the different components of the environment.
3. To develop the understanding of pollution, its causes, and their effects
4. To gain the knowledge of climate change and the contemporary issues

Course Learning Outcomes (CLO) – The Syllabus has been prepared in accordance with the NEP-2020 and based on the UGC curriculum framework. Upon completion of this course, learners will be able to:

1. Demonstrate to safeguard the Earth’s environment and its resources.
2. Explain sustainable development, its goals, challenges, and global strategies.
3. Analyse the environmental pollution and sensitize themselves to adverse health impacts of pollution.
4. Appraise the concept of climate change, its science and response measures.

MAPPING COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

	COURSE LEARNING OUTCOMES (CLOs)			
COURSE OBJECTIVES (COs)	CLO1	CLO2	CLO3	CLO4
CO1	√			
CO2		√		
CO3			√	
CO4				√

COURSE CONTENTS

Unit-1

Human and Environment

Introduction to earth environment, Scope and importance. Components of environment: Lithosphere, Hydrosphere, Biosphere, Atmosphere. The man- environment interaction, Population growth and natural resource exploitation, Industrial revolution, and impact on the environment, Global environmental challenges at global, regional and local level.

Unit-2

Natural Resources, Sustainable Development & Sustainable living

Overview of natural resources: Definition of resource; Classification of natural resources-, renewable, and non-renewable. Resources: Forests, wetlands, Status and challenges. Water resources: Types of water resources, issues and challenges; Soil and mineral resources:

Important minerals; Environmental problems due to extraction of minerals, Soil as a resource and its degradation. Energy resources: renewable and non-renewable sources of energy. Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges, and strategies for SDGs. Ways to live in sustainable manner- Conservation of energy, water at home, plantation, waste segregation, kitchen gardening.

Unit-3

Conservation of Biodiversity and Ecosystems

Biodiversity and its distribution: Biodiversity as a natural resource; Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Major ecosystem types in India and their basic characteristics, forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services- classification and their significance. Threats to biodiversity and ecosystems. Major conservation policies: in-situ and ex-situ conservation approaches; Major protected areas; National and International instruments for biodiversity conservation: The role of traditional knowledge, community-based conservation. Major International Environmental Agreements: Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety, Ramsar Convention on Wetlands of International Importance, The Wildlife (Protection) Act, 1972, The Biological Diversity Act, 2002.

Unit-4

Environmental Pollution and Health

Understanding of pollutant and pollution; Types of Pollution, Air pollution: Sources of air pollution; Primary and secondary pollutants; Criteria pollutants, Indoor air pollution; Adverse health impacts of air pollutants, National Ambient Air Quality Standards. Water pollution: Sources of water pollution; River, lake and marine pollution, groundwater pollution; water quality Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life. Soil pollution and solid waste: Soil pollutants and their sources; Solid and hazardous waste; Impact on human health. Noise pollution: Definition of noise; Unit of measurement of noise pollution; Sources of noise pollution; Noise standards; adverse impacts of noise on human health. Thermal and Radioactive pollution: Sources and impact on human health and ecosystems.

Unit-5

Climate Change: Impacts, Adaptation and Mitigation

Understanding climate change: Natural variations in climate, Anthropogenic climate change from greenhouse gas emissions– past, present and future; Projections of global climate change with special reference to temperature, rainfall, climate variability and extreme events, Climate change projections for the Indian sub-continent. Observed impacts of climate change on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests and natural ecosystems; Impacts on animal species, agriculture, health. the concept of vulnerability, adaptation and resilience, Synergies between adaptation and mitigation measures, Concept of carbon neutrality, net zero targets, Carbon capture and storage, National climate action plan and Intended Nationally Determined Contributions (INDCs).

Unit 6

Case Studies and Field Work

The students are expected to be engaged in one of the following or similar identified activities.

Field visits to identify local issues, make observations including data collection and prepare a brief report, or Documentation of campus biodiversity or Campus environmental management activities such as solid waste disposal, water management, and sewage treatment.

RECOMMENDED TEXT BOOKS:

1. Masters, G. M., & Ela, W. P. (2008). Introduction to environmental engineering and science Englewood Cliffs, NJ: Prentice Hall.
2. Jackson, A. R., & Jackson, J. M. (2000). Environmental Science: The Natural Environment and Human Impact. Pearson Education.
3. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press
4. Environmental Studies for Undergraduate Courses by Erach Bharucha, UGC New Delhi

REFERENCE BOOKS:

1. A.K De Environmental Chemistry New age Publisher, 2016.
2. “Ecology & Environment” P D Sharma, Rastogi Publications, 2009.
3. www.ipcc.org; https://www.ipcc.ch/report/sixth-assessment-report-cycle/.
4. Central Pollution Control Board Web page for various pollution standards. https://cpcb.nic.in/ standards/

Multidisciplinary (Humanities and Social Sciences Courses) Courses (MDC))

Department of Environmental Sciences			
Program: UG program			
Year/Semester	1^{s} Year/I or II	**Course Category**	**MDC**
Course Code		**Course Title**	Environmental Geoscience & Disaster Management
Continuous Evaluation: 40		**End Semester Examination:** 60	
Prerequisite: Nil		**L T P** : 3 0 0	**Credits: 3**

COURSE OBJECTIVES (COs): The Course is designed with the following objectives:

1. To provide fundamental knowledge of earth origin and earth Processes.
2. Educate the students about the types of rocks & geological resources.
3. To understand the Disaster and Disaster management.
4. Role of Geospatial technology in geological resources and Disaster management.

COURSE LEARNING OUTCOMES (CLOs)

The Syllabus has been prepared in accordance with the NEP-2020. Upon completion of this course, learners will be able to:

1. Able to explain the origin and Internal structure of earth.
2. Analyse the Geological resources and geochemistry of minerals.
3. Collect a comprehensive understanding of disaster management.
4. Evaluate the role of technology in disaster management.

MAPPING MATRIX OF COURSE OBJECTIVES (COs) & COURSE LEARNING OUTCOMES (CLOs)

	COURSE LEARNING OUTCOMES (CLOs)			
COURSE OBJECTIVES (COs)	CLO1	CLO2	CLO3	CLO4
CO1	√			
CO2		√		
CO3			√	
CO4				√

COURSE CONTENTS

Unit-1

Origin of the Earth:

Theories and hypothesis of the origin of earth- Oparin-Haldane hypothesis, Big bang theory, the material basis of life, geological time scale, evolution of earth's atmosphere and life through the geological time scale.

Unit-2

Internal Structure of the Earth:

Internal Structure of Earth, differentiation of the earth into core, mantle, crust. Formation of core, mantle, crust, atmosphere, hydrosphere, and biosphere. Convection in Earth's core and production of its magnetic field. Geothermal gradient and internal heat of the Earth. Earthquake and earthquake belts: seismic waves and internal constitution of the Earth. Volcanoes and volcanism, distribution of volcanoes.

Unit-3

Fundamentals of Earth process

Concepts Rocks, Formation of rocks, types of rock (Igneous rock, Metamorphic Rocks, and Sedimentary rocks), Continental drift theory, Plate tectonic, sea floor spreading. Basic concepts of weathering, erosion, and deposition of earth materials by water wind and glaciers.

Unit-4

Geological Resources and Exploration:

Fundamentals of geological resources, their formation, reserves in minerals, coal, oil, gas geological constraints in their availability and use; environmental consequences of their exploitation to air, water, soil, climate, and life. Distribution of minerals in India.

Unit-5

Disaster Management:

Disaster introduction- disaster management, capability vulnerability, risk, preparedness and mitigation. Disaster management cycle. Hazard zonation and mapping- risk reduction measures. Landslide, Earthquake, Tsunami, Flood, Minamata Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukushima Daiichi nuclear disaster, 2011. Role of geo-spatial technology in surveillance, monitoring, risk assessment, and disaster management Sendai Framework for Disaster Risk Reduction.

RECOMMENDED TEXTBOOKS:

1. Mukherjee, S. (2004). Text Book of Environmental remote Sensing. Published by Macmillan India Limited New Delhi ISBN: 1403922357.
2. Keller, E.A. (1996). Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey.
3. Disaster management by R. Subramanian, Vikash Publishing house, ISBN 9352718704

REFERENCE BOOKS

1. Keller, E.A. (1996). Introduction to Environmental Geology. Prentice Hall, Upper Saddle River, New Jersey.
2. J.R Jensen, Remote Sensing of the Environment: An Earth Resource Perspective, 2012