CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

FOR

BACHELOR OF TECHNOLOGY (B.Tech.)

(4 Year Undergraduate Degree Programme)

IN

BIOMEDICAL ENGINEERING

(In Alignment with National Education Policy, 2020)

[w. e. f. 2025-2026]

FACULTY OF ENGINEERING AND TECHNOLOGY

SRM UNIVERSITY DELHI-NCR, SONEPAT

39, Rajiv Gandhi Education City, Sonepat

Haryana-131029

SRM UNIVERSITY DELHI-NCR, SONEPAT

FACULTY OF ENGINEERING AND TECHNOLOGY

ENGINEERING GRADUATES EMPLOYABILITY ATTRIBUTES (EGEAs)

Sound Knowledge and Skills of Basic Sciences & Engineering Sciences:

An Engineer should be able to apply the knowledge of mathematics, science, engineering fundamentals, and an 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 public health and safety, and 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 contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional Engineering practice.

Effective Communication Skills:

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.

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.

Project Management and Finance:

An Engineer must demonstrate knowledge and understanding of the engineering and management principles and apply these to Engineering work environment, as a member and leader in a team, to manage projects and in multidisciplinary environments.

SRM UNIVERISTY DELHI-NCR, SONEPAT

FACULTY OF ENGINEERING AND TECHNOLOGY

FACULTY OF ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES (EPEOs)

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 (EPLOs)

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
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;
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 AND FACULTY OF ENGINEERING PROGRAM LEARNING OUTCOMES

ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES	ENGINEERING PROGRAM LEARNING OUTCOMES
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 AND FACULTY OF ENGINEERINGPROGRAM LEARNING OUTCOMES (TABULAR FORMAT)

Table 1

MAPPING	EPELO1	EPELO2	EPELO3	EPELO4	EPELO5	EPELO6	EPELO7
EPEO1	X	X	X				
EPEO2	X	X	X	X			
EPEO3			X	X	X	X	
EPEO4					X	X	
EPEO5						X	X

SRM UNIVERSITY DELHI-NCR, SONEPAT

DEPARTMENT OF BIOMEDICAL ENGINEERING

BIOMEDICAL ENGINEERING

GRADUATES EMPLOYABILITY ATTRIBUTES

EA1: A Sound knowledge & skills base for engineering: Demonstrated competence in university-level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.

EA2: Application of Biological & Engineering knowledge to analyze the problem in healthcare:

An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.

EA3: Design and modeling of biomedical instruments and analytical instruments:

Ability to design solutions for complex, open-ended engineering problems and to design systems, components/processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural, and societal considerations.

Application of core subjects, interdisciplinary Subjects, programming, and strong coding knowledge in real life situations/problems:

An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations in real-life problems.

DEPARTMENT OF BIOMEDICAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1. To apply broad-based knowledge of mathematics, engineering, physical sciences, and life sciences to solve biomedical engineering problems, including those associated with the interactions between living and non-living systems.

PEO2. To perform measurements on, and interpret data from, both living and non-living systems.

PEO3. To apply critical reasoning as well as quantitative and design skills to identify and solve problems in biomedical engineering.

PEO4. To lead and manage biomedical engineering projects in industry, government, or academia that involve multidisciplinary team members.

PEO5. To enter into industry jobs in prominent companies as engineers who work in the areas of medical device design, manufacturing, quality control, marketing and so much more, as they work toward the advancement of medicine.

PE06. To broaden the education by attending professional school in areas of imaging, sensing, therapeutics, biomechanics, cell and tissue engineering, and computational and systems biology.

PROGRAM LEARNING OUTCOMES (PLOs)

PLO1-Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and IC design and technology concepts towards modeling 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 modeling 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 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 teamwork: 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 comprehend 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 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.

TABLE 2: MAPPING BETWEEN PROGRAM EDUCATIONAL OBJECTIVES (PEOs) AND PROGRAM LEARNING OUTCOMES (PLOs)

PEOs/PLO	Program Learning Outcomes (PLOs)											
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
PEO1	X	X		X		X	X					X
PEO2		X		X	X				X			
PEO3		X	X	X	X			X		X		
PEO4			X				X	X	X		X	
PEO5			X					X	X	X	X	
PEO6					X	X						X

B. TECH (BIOMEDICAL ENGINEERING)

PROGRAM STRUCTURE IN ALIGNMENT WITH NATIONAL EDUCATION POLICY, 2020

- **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, Chemistry in the mind of the learners, so that they proceed to 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 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 (PC):** 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 latest software's to conduct practical as per the requirement of the University Curriculum.

- **Professional Electives (PE) – 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 (AEC)**

  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 at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and academic writing skills. The focus is on imparting students with 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 (SEC) – Technical & Soft Skills:**
    - **Technical Skills:** Under Technical Skills Broad categories of training 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 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 disciplinesintroduced to inculcate Group Dynamics, Team work & Leadership Traits by engaging students for interactive sessions through Role Play, Group Discussions and for improving presentation &Communication skills of engineering graduates.(One Credit Course from 3rd Semester to 7th semester).

- **Value Added Courses (VAC):**

    Course components relating to skills, attitudes, and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, and sustainable development and 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):**
    - ❖ Student 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, report. In addition to this, it provides a detail to students about internship/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 multidisciplinary approach.

SRMUH FOUR YEAR UNDERGRADUATE PROGRAM STRUCTURE IN ALIGNMENT WITH NATIONAL EDUCATION POLICY 2020 (NEP 2020)

TABLE 3: PROGRAM STRUCTURE FOR BACHELOR OF TECHNOLOGY (BIOMEDICAL ENGINEERING) DEGREE COURSE

SL. No.	Course Category	Course Code	Number of Courses
1	Basic Applied Sciences	BAS	7
2	Engineering Sciences	ES	10
3	Professional Core	PC	12
4	Professional Electives -Program-Specific Specialized Elective Courses	PE	11
5	Ability Enhancement Courses	AEC	4
6	Skill Enhancement courses (Technical and Soft skills)	SEC	10
7	Value Added Courses	VAC	3
8	Practical / Workshop	P/W	11
9	Live Project & Industrial Visit and Summer Internship	LP/SI	6
10	Multidisciplinary (Humanities and Social Sciences Courses) Courses (MDC)	MDC	3
TOTAL NUMBER OF COURSES			77

SRMUH FOUR YEAR UNDERGRADUATE PROGRAM CREDIT STRUCTURE IN ALIGNMENT WITH NATIONAL EDUCATION POLICY 2020 (NEP 2020)

TABLE 4: PROGRAM CREDIT STRUCTURE SEMESTERWISE FOR BACHELOR OF TECHNOLOGY (BIOMEDICAL ENGINEERING) DEGREE COURSE

SL. No	Course Category	Course Code	Credits Per Semester								Total Credits	% AGE
			I	II	III	IV	V	VI	VII	VIII		
1	Basic Applied Sciences	BAS	9	9	4	-					22	12.22
2	Engineering Sciences	ES	9	9	0	-					18	10.00
3	Professional Core	PC	-		9	11	7	8	6		41	22.78
4	Professional Electives - Program-Specific Specialized Elective Courses	PE	-		3	3	9	9	9		33	18.33
5	Ability Enhancement Courses	AEC	5	2							7	3.89
6	Skill Enhancement courses (Technical and Soft skills)	SEC	-		2	2	2	2	2		10	5.56
7	Value Added Courses	VAC	2	2	2	-	0				6	3.33
8	Practical / Workshop	P/W			3	4	3	2	2		14	7.78
9	Live Project & Industrial Visit and Summer Internship	LP/SI	-			1	1	1	5	12	20	11.11
10	Multidisciplinary (Humanities and Social Sciences Courses) Courses (MDC)	MDC	-			3	3	3			9	5.00
TOTAL			25	22	23	24	25	25	24	12	180	100

PROGRAMME COURSES SRUCTURE SEMESTERWISE
BACHELOR OF TECHNOLOGY
(BIOMEDICAL ENGINEERING)

TABLE 5: PROGRAM COURSE'S C R E D I T STRUCTURE SEMESTER-WISE

SEMESTER – I

SL. No	Code	Category	Course Name	Hours per week				Credits
				L	T	P	Total Hours	
THEORY								
1	24AS101	(BAS)	Engineering Mathematics-I	3	1	0	4	4
OR								
1 (a)	24AS104	(BAS)	Elementary Mathematics-I (For BME students)	2	0	0	2	2
1 (b)	24AS105	(BAS)	Elementary Biology (For BME students)	1	1	0	2	2
2	24AS102/ 24AS103	(BAS)	Engineering Physics/ Engineering Chemistry	3	1	0	4	4
3	24EE101/ 24EC101	(ES)	Basic Electrical Engineering / Basic Electronics Engineering	3	0	0	3	3
4	23ME101/ 23CS101	(ES)	Engineering Mechanics / Fundamentals of Computer & C Programming	3	0	0	3	3
5	24HS101	(AEC)	Communicative English (*50% of students will be offered)	2*	0	0	2*	2*

6	24HIN-101-I / 24FLGR101-I / 24FLFR101-I	(AEC)	Hindi-I/German-I/French-I	2	0	0	2	2
7	23ESEB101/ 23VAC102	(VAC)	Environmental Bioengineering / Indian Constitution and Polity	2	0	0	2	2
Total Credits (Theory)				**16/18**	**2**	**0**	**18/20**	**18/20**
PRACTICAL								
8	24AS152/24AS153	(BAS)	Engineering Physics Lab/Engineering Chemistry Lab	0	0	2	2	1
9	23EE151/24EC151	(ES)	Basic Electrical Engineering Lab / Basic Electronics Engineering Lab	0	0	2	2	1
10	23ME151/23CS151	(ES)	Basic Mechanical Engineering Lab/ C Programming Lab	0	0	2	2	1
11	23ME152/23ME153	(ES)	Mechanical Workshop Lab/Engineering Graphics & Design Lab	0	0	2	2	1
12	24HS151*	(AEC)	Communicative English Lab (50% of students will be offered)	0	0	2*	2*	1*
Total Credits (Practical)				**0**	**0**	**8/10**	**8/10**	**4/5**
TOTAL CREDITS (THEORY + PRACTICAL)				**16/18**	**2**	**8/10**	**26/30**	**22/25**

** 1 credit practical i.e. 24CAM101- INDUSTRIAL SESSION – I will be offered to IBM Specialization students.

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

SEMESTER – II

SL. No	Code	Category	Course Name	Hours per week				Credits
				L	T	P	Total Hours	
THEORY								
1	24AS201	(BAS)	Engineering Mathematics-II	3	1	0	4	4
OR								
1	24AS204	(BAS)	Elementary Mathematics II (For BME students)	3	1	0	4	4
2	24AS202/ 24AS203	(BAS)	Engineering Physics/ Engineering Chemistry	3	1	0	4	4
3	24EE201/ 24EC201	(ES)	Basic Electrical Engineering / Basic Electronics Engineering	3	0	0	3	3
4	23ME201/ 23CS201	(ES)	Engineering Mechanics / Fundamentals of Computer & C Programming	3	0	0	3	3
5	24HS201	(AEC)	Communicative English (*50% of students will be offered)	2*	0	0	2*	2*
6	24HIN-201-II / 24FLGR201-II/ 24FLFR201-II	(AEC)	Hindi-II/German-II/French-II	2	0	0	2	2
7	23ESEB201/2 3VAC 202	(VAC)	Environmental Bioengineering / Indian Constitution and Polity	2	0	0	2	2
Total Credits (Theory)				**16/18**	**2**	**0**	**18/20**	**18/20**
PRACTICAL								

8	24AS252/24AS253	(BAS)	Engineering Physics Lab/Engineering Chemistry Lab	0	0	2	2	1
9	23EE251/ 24EC251	(ES)	Basic Electrical Engineering Lab / Basic Electronics Engineering Lab	0	0	2	2	1
10	23ME251/23CS251	(ES)	Basic Mechanical Engineering Lab/ C Programming Language Lab	0	0	2	2	1
11	23ME252/23ME253	(ES)	Mechanical Workshop Lab/Engineering Graphics & Design Lab	0	0	2	2	1
12	24HS251*	(AEC)	Communicative English Lab (50% of students will be offered)	0	0	2*	2*	1*
Total Credits (Practical)				**0**	**0**	**8/10**	**8/10**	**4/5**
Total Credits (Theory + Practical)				**16/18**	**2**	**8/10**	**26/30**	**22/25**

** 1 credit practical i.e. 24CAM201- INDUSTRIAL SESSION –II will be offered to IBM Specialization

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

***3 Week long Induction Programme right at the start of the 1st Semester. Normal class start onlyafter the induction programme is over.**

SEMESTER – III

SL.No	Code	Category	Course	Hours per week				Credits
				L	T	P	Total Hours	
Theory								
1	24MA301	(BAS)	Application of Mathematics in BME	3	1	0	4	4
2	24BM301	(PC)	Transducers and Biosensors	3	0	0	3	3
3	24BM302	(PC)	Human Anatomy and Physiology	3	0	0	3	3
4	24BMPXX X	(PE)	Professional Elective-I	3	0	0	3	3
5	24BM303	(PC)	Biochemistry	3	0	0	3	3
Total Credits (Theory)				15	1	0	16	16
Practical								
6	24BM351	(P)	Transducers and Biosensor Lab	0	0	4	4	2
7	24BM353	(P)	Biochemistry Lab	0	0	2	2	1
8	23VAC103	(VAC)	Sports, Yoga & Fitness	2	0	0	2	2
Total Credits (Practical)				2	0	6	8	5
Skill Enhancement								
9	24CS0201A/24CS0201B/24CS0201C/24CS0201D	(SEC)	Data Structure and Algorithms using C or C++/Industry Automation Level-I/ Digital Marketing/Fundamentals of CAD for Engineers	0	0	2	2	1
10	23SS351	(SEC)	Effective Communication Skills	0	0	2	2	1
Total Credits (Skill Enhancement)				0	0	4	4	2
Total Credits (Theory + Practical + Skill Enhancement)				17	1	10	28	23

SEMESTER – IV

SL.No	Code	Category	Course	Hours per week				Credits
				L	T	P	Total Hours	
Theory								
1	24MDC401	(MDC)	Multidisciplinary Elective-I	3	0	0	3	3
2	24BM401	(PC)	Introduction to Python	3	0	0	3	3
3	24BM402	(PC)	Biomedical Instrumentation	3	1	0	4	4
4	24BM403	(PC)	Linear Integrated Circuits	3	1	0	4	4
5	*24BMPX XX	(PE)	Professional Elective - II	3	0	0	3	3
Total Credits (Theory)				15	2	0	17	17
Practical								
6	24BM452	(P)	Biomedical Instrumentations Lab	0	0	4	4	2
7	24BM453	(P)	Linear Integrated Circuits Lab	0	0	4	4	2
8	23BM461	(LP/SI)	#Live Project-I & Industrial Visits	0	0	1	2(1)	1
Total Credits (Practical)				0	0	7	9	5
Skill Enhancement								
9	23S452	(SEC)	Teamwork & Interpersonal Skills	0	0	2	2	1
10	24CS0202A/24CS0202B/24CS0202C	(SEC)	Introduction to SPSS Tool/Design Thinking and Augmented Virtual Reality/Programming Using Python for Engineers	0	0	2	2	1
	Total Credits (Skill Enhancement)			0	0	4	4	2
Total Credits (Theory + Practical + Skill Enhancement)				15	2	11	30	24

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

Industrial visit will be conducted by the department during current semester ad evaluation will be carried out at the end of semester.

SEMESTER – V

SL.No	Code	Category	Course Name	Hours per week				Credits
				L	T	P	Total Hours	
Theory								
1	24MDC501	(MDC)	Multidisciplinary Elective-II	3	0	0	3	3
2	24BM502	(PC)	Advanced Biomedical Instrumentation	3	1	0	4	4
3	24BM501	(PC)	Introduction to MATLAB	3	0	0	3	3
4	*24BMPXXX	(PE)	Professional Elective – III	3	0	0	3	3
5	*24BMPXXX	(PE)	Professional Elective – IV	3	0	0	3	3
6	*24BMPXXX	(PE)	Professional Elective-V	3	0	0	3	3
Total Credits (Theory)				18	1	0	19	19
Practical								
7	24BM551	(P)	MATLAB Lab	0	0	2	2	1
8	24BM552	(P)	Advanced Instrumentation Lab	0	0	2	2	1
9	24BMPXXX	(P)	Professional Elective- III lab	0	0	2	2	1
10	23BM561	(LP/SI)	#Live Project II &Industrial training	0	0	1	2(1)	1
Total Credits (Practical)				0	0	7	7	4
Skill Enhancement								
11	23SS553	(SEC)	Presentation Skills	0	0	2	2	1
12	24CS0301A/24CS0301B/24CS0301C/24CS0301D/24CS0301E	(SEC)	Wearable Technology/Big Data Analytics, Tools and Techniques/Machine Learning using Python/Industry Automation Level-II/RCC Structure Drawing Training	0	0	2	2	1
Total Credits (Skill Enhancement)				0	0	4	4	2
Total Credits (Theory + Practical + Skill Enhancement)				18	1	11	30	25

To be carried out during semester break of 4th semester. Evaluation to be carried out during 5th semester.

SEMESTER – VI

SL.No	Code	Category	Course	Hours per week				Credits
				L	T	P	Total Hours	
Theory								
1	24MDCXXX	(MDC)	Multidisciplinary Elective-III	3	0	0	3	3
2	24BM601	(PC)	Medical Imaging and its Applications	3	1	0	4	4
3	24BM602	(PC)	Biomaterials and Artificial organs	3	1	0	4	4
4	*24BMPXXX	(PE)	Professional Elective-VI	3	0	0	3	3
5	*24BMPXX X	(PE)	Professional Elective-VII	3	0	0	3	3
6	*24BMPXX X	(PE)	Professional Elective-VIII	3	0	0	3	3
Total Credits (Theory)				18	2	0	20	20
Practical								
7	24BM651	(P)	Medical Imaging Lab	0	0	2	2	1
8	24BM652	(P)	Biomaterials Lab	0	0	2	2	1
9	23BM659	(LP/SI)	#Live Project III & Industrial Visit	0	0	1	2(1)	1
Total Credits (Practical)				0	0	5	5	3
Skill Enhancement								
10	23SS654	(SEC)	Professional Skills	0	0	2	2	1
11	24CS0302A/24CS0302B/24CS0302C/24CS0302D	(SEC)	Artificial Intelligence andMachine Learning/MATLAB for Engineers/ Structural Analysis using FEM-based Tools/Data Analytics Tools	0	0	2	2	1

Total Credits (Skill Enhancement)	0	0	4	4	2
Total Credits (Theory + Practical + Skill Enhancement)	18	2	9	29	25

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

*The XXX part of the course code will depend upon the elective chosen by the student

Industrial visit will be conducted by the department during current semester ad evaluation will be carried out at the end of semester.

SEMESTER – VII

SL.No	Code	Category	Course	Hours per week				Credits
				L	T	P	Total Hours	
Theory								
1	*24BMPXXX	(PE)	Professional Elective -IX	3	0	0	3	3
2	*24BMPXXX	(PE)	Professional Elective -X	3	0	0	3	3
3	*24BMPXXX	(PE)	Professional Elective -XI	3	0	0	3	3
4	24BM701	(PC)	Biomechanics of Soft and Hard Tissues	3	0	0	3	3
5	24BM702	(PC)	Microprocessor and Microcontroller	3	0	0	3	3
Total Credits (Theory)				15	0	0	15	15
Practical								
6	23BM752	(P)	Microprocessor And Microcontroller Lab	0	0	2	2	1
7	23BMPXXX	(P)	PE X lab	0	0	2	2	1
8	23BM757	(LP)	**Minor Project	0	0	8(4) **	4	4
9	23BM759	(LP/SI)	#Live Project-IV & Industrial Visits	0	0	2	2	1
Total Credits (Practical)				0	0	10	10	7
Skill Enhancement								
10	23AR755	(SEC)	Aptitude & Reasoning	0	0	2	2	1
11	24CS0401A /24CS0401 B/24CS040 1C/24CS04 01D	(SEC)	Building information modeling/PLC Programming/ FPGA for Embedded Systems/Essentials of Blockchain and IoT	0	0	2	2	1
Total Credits (Skill Enhancement)				0	0	4	4	2
Total Credits (Theory + Practical + Skill Enhancement)				15	0	14	29	24

The XX parts of the course code will depend upon the elective chosen by the student.
**To be monitored at the Institute Level. Teaching Load for ERP
#To be carried out after 6th semester during semester break. Evaluation to be carriedout in 7th Semester.

SEMESTER – VIII

SL.No	Code	Category	Course	Hours per week				Credits
				L	T	P	Total Hours	
Practical								
1	23BM857	(LP/SI)	*Major Project (Industrial Internship)	0	0	24	24 (6) **	12
Total Credits (Practical)				0	0	24	24 (6) **	12

***To be monitored at the Institute Level**

****Teaching Load**

L : Lecture **T : Tutorials** **P: Practical**	**BAS : Basic Applied Sciences** **ES : Engineering Sciences** **PC : Professional Core Courses** **PE : Professional Electives** **P/W : Practical / Workshop** **AEC : Ability Enhancement Courses** **VAC : Value Added Courses** **SEC : Skills Enhancement Course** **LP : Live Projects & Summer Internship** **MDC : Multidisciplinary Courses**

Department Elective Courses of Specialization in Major Degree Of Biomedical Engineering

PROGRAM SPECIALIZATION CATEGORY-I

PROGRAM ELECTIVE SPECIALIZATION COURSES UNDER THE DEGREE OF BIOMEDICAL ENGINEERING

Basket-I of Program Elective Courses

[Specialization in Medical Instrumentation]

S.No.	Code	Course	Category	L	T	P	C
1.	#24BMP301	Electronic Devices and Circuits	PE-I	3	0	0	3
2.	24BMP302	Analog and Digital Communication		3	0	0	3
3.	24BMP401	Hospital Safety and Management	PE-II	3	0	0	3
4.	24BMP402	Digital Electronics		3	0	0	3
5.	24BMP403/ 24BMP453	Therapeutic and Assist Devices & Lab	PE-III	3	0	0	3
6.	24BMP404/ 24BMP454	Biophysical Signals and Systems & lab		3	0	0	3
7.	24BMP501	Biomedical Laser Instrumentation	PE-IV	3	0	0	3
8.	24BMP502	Telemedicine and Remote Patient Monitoring		3	0	0	3
9.	24BMP503	Optical Instrumentation	PE-V	3	0	0	3
10.	24BMP504	Rehabilitation Engineering		3	0	0	3
11.	24BMP505	Biological Control System	PE-VI	3	0	0	3
12.	24BMP506	Biosensor, Drug Design and Development		3	0	0	3
13.	24BMP601	Neural Networks & Fuzzy Control	PE-VII	3	0	0	3
14.	24BMP602	Statistical Computing with R		3	0	0	3
15.	24BMP603	Nanotechnology and Clinical Science	PE-VIII	3	0	0	3
16.	24BMP604	Deep Learning & Machine Learning in Health Care		3	0	0	3

17.	24BMP605	Medical Image Processing	PE-IX	3	0	0	3
18.	24BMP606	Designing Concept, Maintenance, and Troubleshooting of Bioinstrumentation		3	0	0	3
19.	24BMP701/ 24BMP751	Biomedical Signal Processing and lab	PE-X	3	0	0	3
20.	24BMP702/ 24BMP752	Mathematical Modeling and Simulation with MATLAB & Lab		3	0	0	3
21.	24BMP703	Bioethics, Biosafety and IPR	PE-XI	3	0	0	3
22.	24BMP704	Advanced Medical Imaging		3	0	0	3

Note: Students may opt one course in 6^{th} semester and one course in 7^{th} semester apart from the elective list (as elective) from NPTEL on recommendation of departmental committee.

PROGRAM SPECIALIZATION CATEGORY-II

PROGRAM ELECTIVE SPECIALIZATION COURSES UNDER THE DEGREE OF BIOMEDICAL ENGINEERING

Basket-II of Program Elective Courses

[Specialization in Medical Informatics and Biotechnology]

S.No.	Code	Course	Category	L	T	P	C
1.	24BMP301	Electronic Devices and Circuits	PE-I	3	0	0	3
2.	24BMP302	Analog and Digital Communication		3	0	0	3
3.	#24BMP411	Healthcare Data Management System	PE-II	3	0	0	3
4.	24BMP412	Introduction to medical informatics		3	0	0	3
5.	24BMP413/	Elements of Biotechnology & Lab	PE-III	3	0	0	3
6.	24BMP414/	Bioinformatics & Labb		3	0	0	3
7.	24BMP511	Microbiology	PE-IV	3	0	0	3
8.	24BMP502	Telemedicine and Remote Patient Monitoring		3	0	0	3
9.	24BMP513	Immunology	PE-V	3	0	0	3
10.	24BMP504	Omics for BME		3	0	0	3
11.	24BMP515	Molecular Biology	PE-VI	3	0	0	3
12.	24BMP506	Biosensor, Drug Design and Development		3	0	0	3
13.	24BMP611	Recombinant DNA Technology	PE-VII	3	0	0	3
14.	24BMP602	Statistical Computing with R		3	0	0	3
15.	24BMP603	Nanotechnology and Clinical Science	PE-VIII	3	0	0	3
16.	24BMP604	Deep Learning & Machine Learning in Health Care		3	0	0	3
17.	24BMP605	Medical Image Processing	PE-IX	3	0	0	3
18.	24BMP606	Natural Language Processing (NLP) in Healthcare		3	0	0	3
19.	24BMP701	Biomedical Signal Processing and lab	PE-X	3	0	0	3
20.	24BMP702	Mathematical Modeling and Simulation with MATLAB & lab		3	0	0	3

21.	24BMP703	Bioethics, Biosafety and IPR	PE-XI	3	0	0	3
22.	24BMP704	Advanced Medical Imaging		3	0	0	3

#24BMPX0X: Medical Instrumentation or for common subjects and 24BMPX1X is for Medical Informatics and Biotechnology

Note: Students may opt for one course in 6th semester and one course in 7th semester apart from the elective list (as elective) from NPTEL on recommendation of departmental committee.

SKILL ENHANCEMENT COURSES (SEC)

Category	Course Code	Course Name	L	T	P	Credits
Technical Training						
SEC	24CS0201A/24CS0201B/24CS0201C/24CS0201D	Data Structure and Algorithmsusing 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
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

ABILITY ENHANCEMENT COURSES (AEC)

Total: 6 (3*2) Credits						
University Pool Common to all UG Programs						
Code	**Category**	**Course**	**L**	**T**	**P**	**C**
24HS101/24HS201	(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
24HS151/24HS251	(AEC)	Communicative English Laboratory	0	0	2	1

VALUE ADDED COURSES (VAC)

Total: 6 (2*3) Credits						
Code	**Category**	**Course**	**L**	**T**	**P**	**C**
23ESEB101/24ESEB201	(VAC)	Environment Bioengineering	2	0	0	2
23VAC101/24VAC201	(VAC)	Environment Protection and Sustainable Development	2	0	0	2
23VAC102/24VAC202	(VAC)	Indian Constitution and Polity	2	0	0	2
23VAC103	(VAC)	Sports, Yoga and Fitness	2	0	2	2
Note:						
1. All Courses are compulsory for the students.						
2. Students would be encouraged to opt NCC/NSS.						

MULTI-DISCIPLINARY COURSES (MDC)

Total: 9 (3*3) Credits						
Code	**Category**	**Course**	**L**	**T**	**P**	**C**
23MDC101/24MDC101A/24MDC101B/24MDC101C/24MDC101D	(MDC-I)	Statistical Methods/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 106A/24MDC 106B		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
24MDC107		Probability & Statistics	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.						

Note: Students may opt one course in 6th semester and one course in 7th semester apart from the elective list (as elective) from NPTEL on recommendation of departmental committee.

NPTEL COURSE LIST

S. No.	Name of the Course	L	T	P	C
1.	Electronic Devices and Circuits	3	0	0	3
2.	Analog Electronic Circuits	3	0	0	3
3.	Mapping Signal Processing Algorithms to Architectures	3	0	0	3
4.	Digital IC Design	3	0	0	3
5.	Principles of Communication Systems	3	0	0	3
6.	Microprocessors and Interfacing	3	0	0	3
7.	Digital Circuits and Systems	3	0	0	3
8.	Hospital Management	3	0	0	3
9.	Biomedical Signal Processing	3	0	0	3
10.	Optoelectronic Materials and Devices	3	0	0	3
11.	Physics of Nanoscale Devices	3	0	0	3
12.	Control Engineering	3	0	0	3
13.	Neural Networks for Signal Processing	3	0	0	3
14.	Semiconductor device modeling and Simulation	3	0	0	3
15.	Introduction to R Software	3	0	0	3
16.	Introduction to Nanotechnology	3	0	0	3
17.	Deep Learning	3	0	0	3
18.	Mathematical Modelling of Systems	3	0	0	3
19.	Medical Imaging	3	0	0	3
20.	Analog Signal Processing	3	0	0	3
21.	Health Informatics	3	0	0	3
22.	Bioinformatics	3	0	0	3

SEMESTER 1

Elementary Mathematics-I (For BME only)	
Course Code:24AS104	Continuous Evaluation: 40 Marks
Credits: 2	End Semester Examination:60 Marks
L T P : 2 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To introduce the concept of Matrices and Determinants.
2. To introduce the concept of Differentiation.
3. To introduce the concept of Integration.
4. To get the knowledge that 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 computer science.
3. Apply the integrals in computer applications.
4. Understand the differential equations and their simple applications.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS

Unit-1: Matrices and determinants **(6 Lectures)**

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,

Unit-2: Differential Calculus **(6 Lectures)**

Introduction, Continuity, Differentiability-Chain Rule, Derivatives of implicit functions, Derivatives of Trigonometric functions and Inverse trigonometric functions, Derivatives of Exponential and Logarithmic functions.

Unit-3: Integral Calculus **(6 Lectures)**

Introduction, Elementary Properties, Integration by method of Substitution, Integration using trigonometric identities, Integration by Partial fractions, Integration by parts.

Definite Integrals, Properties, Evaluation of definite Integrals.

Unit-4: Ordinary Differential Equations **(6 Lectures)**

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.

TEXT BOOKS/ REFERENCE BOOKS

1. Grewal B.S, Higher Engineering Mathematics, Khanna Publications, 44th Edition, 2017.
2. Jain R. K., Iyengar S. R. K., "Advanced Engineering Mathematics", 6th Edition, Narosa Publishing House, 2019.
3. Kreyszig. E, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons. Singapore, 2015.
4. Bali N.P., Goyal M, Advanced Engineering Mathematics, Laxmi Publications, New Delhi, 2018.
5. Dass H. K., Advanced Engineering Mathematics, Sultan Chand Publication, Delhi, 2018.

ELEMENTARY BIOLOGY (For BME only)	
Course Code: 24AS105	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 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.

MAPPING MATRIX OF COURSE OBJECTIVES (CO) & COURSE LEARNING OUTCOMES (CLO)

COURSE OBJECTIVES	COURSE LEARNING OUTCOMES					
	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6

CO1	✓					
CO2	✓	✓				
CO3		✓	✓			
CO4				✓	✓	
CO5				✓	✓	
CO6					✓	✓

COURSE CONTENTS:

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.

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.

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.

UNIT IV: PHYSIOLOGY

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

ENGINEERING PHYSICS	
Course Code: 24AS102/24AS202	**Continuous Evaluation:** 40 Marks
Credits: 4	**End Semester Examination:** 60 Marks
L T P : 3 1 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To provide students with the knowledge of variety of important concepts of Physics and their applications in Engineering and Technology
2. To enhance the understanding of the concepts found in Mechanics, Harmonic Oscillations, wave Optics, Lasers, Fiber Optics.
3. To familiarize the quantum mechanical approach and its application in engineering.
4. To develop necessary understand on semiconductors and their applications in devices; Apply theory learnt to correlate with the environmental issues such as the use of solar cells

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. The student is expected to be familiar with broader areas of Physics such as mechanics of solids, optics, mechanical and electromagnetic waves oscillations and their relevance in Engineering.
2. An understanding of Physics also helps engineers understand the working and limitations of existing devices and techniques, which eventually leads to new innovations and improvements.
3. The student would be able to learn the fundamental concepts on Quantum behavior of matter in its micro state.
4. The course also helps the students to be exposed to the phenomena of electromagnetism and also to have exposure to semiconductor devices such as solar cell.

MAPPING BETWEEN COURSE OBJECTIVES AND COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓		✓	
CO2	✓	✓		

CO3			✓	
CO4				✓

COURSE CONTENTS

Unit- 0: Fundamentals: Newtonian mechanics, Moment of Inertia, Friction, Work-Power-Energy, Conservation Laws, Thermodynamic Laws, Electro-Magnetic Spectrum, Huygen wave theory, Intrinsic and Extrinsic semiconductors.

Unit-1: WAVES AND OSCILLATIONS:

Oscillations: Simple Harmonic Motion (SHM), Differential Equation of SHM and its Solutions, Conservation of Energy. Mass-string System. Damped Harmonic Oscillator-Overdamped, Critically Damped, Under Damped motions, Relaxation Time, Forced vibrations. Resonance & Quality Factor.

Unit-2 : ELECTROMAGNETIC THEORY AND FIBER OPTICS:

Mathematical Background: Gradient, Divergence, curl (Physical Significance), Irrotational & Solenoidal Field, Gauss Divergence and Stoke's Theorem, Maxwell's Equation in Integral & Differential forms. Wave equation for Electromagnetic (EM) Waves-Propagation in free space, Characteristic Impedance, Poynting theorem (only definition). **Fiber optics:** Structure of optical Fiber, Principle of propagation and numerical aperture, acceptance angle and classification of optical fiber (single mode and multimode).

Unit-3: OPTICS AND LASER:

Interference: Superposition Principle, Division of Amplitude-Interference in Thin Films, Application: Interference in Wedge shaped Film, Application: Newton's Ring. Diffraction: Fraunhoffer Vs Fresnel Diffractions, Fraunhoffer Diffraction in Single & Multiple slits/Grating, Resolving power & Dispersive power of grating and prism. Laser: Spontaneous and stimulated emission, Einstein's coefficients, Characteristics of laser, Ruby Laser.

Unit-4: STATISTICAL MECHANICS AND QUANTUM MECHANICS:

Qualitative treatment of Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics, Black body problem, Photoelectric effect and Compton scattering (For concept), de Broglie Hypothesis of matter waves, de-Broglie waves-Phase & Group Velocities, Davison-Germer experiment, Uncertainty Principle, Application of Uncertainty Principle, Significance of Wave Functions, Postulates of Quantum Mechanics, Schrodinger equation-Time dependent and time independent equation Application: Particle in a box (1-D).

Unit-5 : SEMICONDUCTOR AND OPTOELECTRONIC DEVICES

Fermi level in intrinsic and extrinsic semiconductors, Effect of temperature and carrier concentration (qualitative), Direct and indirect bandgap semiconductor, LED, Photodiode, LDR, Photovoltaic effect, and Solar Cell. Hall Effect: Hall coefficient and its applications.

TEXT BOOKS

1. Beiser A, Concepts of Modern Physics, 5th Ed., McGraw Hill International, 2003.
2. AjoyGhatak, Optics, 5th Ed., Tata McGraw Hill, 2012.
3. David J. Griffiths, Introduction to Electrodynamics, Pearson Education Limited, London, 2015.
4. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker , Wiley
5. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
6. Engineering Mechanics (SIE), S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati , McGraw Hill

REFERENCE BOOKS

1. Arumugam, M., Engineering Physics, 2nd edition, Anuradha Publishers, KumbaKonam, 2003.
2. Gaur and Gupta, Engineering Physics, 7th edition, Dhandapani and Sons, New Delhi, 1997.
3. N. Subrahmanyam and Brij Lal, Waves and Oscillations.
4. David J. Griffiths, Introduction to Quantum Mechanics, Pearson Education Limited.

ENGINEERING CHEMISTRY	
Course Code: 24AS103 /24AS203	**Continuous Evaluation:** 40 Marks
Credits: 4	**End Semester Examination:** 60 Marks
L T P : 3 1 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. The knowledge of water quality parameters and the treatment of water.
2. Explain states of matter, phase diagram and related applications.
3. To learn various types of fuels and their properties, and to understand the basics of spectroscopy.
4. To understand the fundamental concepts of corrosion chemistry.
5. To learn an introductory idea about new materials.

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:

1. Understand to identify the quality of water and how to improve the quality of water.
2. Explain states of matter, phase diagram, related applications and polymers.
3. Analyze the quantitative aspects of fuel combustion, spectroscopy
4. Explain the mechanism of corrosion.
5. Get preliminary understanding on introductory idea about nano materials.

MAPPING BETWEEN COURSE OBJECTIVES AND COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-0 : General Introduction: Importance and scope of Chemistry:

Atomic and molecular masses, mole concept and molar mass, percentage composition, redox reactions, Chemical and ionic equilibrium; Acid & bases.

Unit-1 : 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.

Unit-2: 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 component system-Eutectic, Pb-Ag system.

Polymer: Terminologies, Classification of polymer, Preparation of special polymer-Nylon 6, 6, Polyethylene, Polystyrene, Teflon, Polymethyl-methacrylate, Bakelite.

Unit-3 : **Fuels:**

Classification of fuels, calorific value. G.C.V. and N.C.V., Solid fuels, Analysis of coal. Liquid fuels: Classification of petroleum, refining of petroleum, Cracking, Knocking and anti-knocking, cetane and octane numbers.

UV Spectroscopy: Lambert Beer's Law, Principles and applications of UV-Visible Molecular Absorption Spectroscopy; Chromophores, effect of conjugation on chromophores.

Unit-4: 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.

Unit-5: New Materials:

Introduction to nanomaterials, 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.

TEXT BOOKS

1. Engineering Chemistry (NPTEL web-book) by B. L. Tembe, Kamaludddin and M. S. Krishan.
2. Fundamentals of Molecular Spectroscopy by Banwell, Tata McGraw Hill Education.
3. Textbook of nanoscience and Nanotechnology, McGraw Hill Education (India) Pvt. Ltd., 2012.
4. Engineering Chemistry by Jain and Jain, DhanpatRai Publication.
5. Engineering Chemistry by Prasanta Rath, Cenage Learning India Private Ltd., 2015.
6. A text book of Engineering Chemistry by Shashi Chawla, DhanpatRai& Co. 2020
7. Inorganic Chemistry by Donald A. Tarr, 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 Univesity Press, 6th edition.
2. Advanced Engineering Chemistry by M. R. Senapati, University Science Press, India.
3. A Text book of Engineering Chemistry by S.S. Dara, 10th Edition, S. Chand & Company Ltd., New Delhi, 2003

BASIC ELECTRICAL ENGINEERING	
Course Code: 24EE101/24EE201	**Continuous Evaluation:** 40 Marks
Credits: 3	**End Semester Examination:** 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. Students will gain knowledge regarding the various laws and principles associated with electrical systems.
2. Students will gain knowledge regarding electrical machines and apply them to practical problems.
3. Students will acquire knowledge in using the concepts in the field of electrical engineering.

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. The syllabus has been prepared in accordance with National Education Policy (NEP). After completion of the course, students would be able to:
2. To explain the strong basics of electrical engineering and practical implementation of electrical fundamentals.
3. To identify different applications of commonly used electrical machinery.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓	✓	
CO3			✓	✓

COURSE CONTENTS

Unit-1: DC CIRCUITS AND ELECTROMAGNETISM (8 Hrs.)

Ohm's Law and Kirchhoff's Laws, Analysis of Series, parallel, and series-parallel circuits excited by independent voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem. Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance, and coefficient of coupling; Energy stored in magnetic fields

Unit-2: Single Phase A.C. Circuits:

Sinusoidal signal, instantaneous and peak values, RMS and average values, crest and peak factor, Concept of phase, representation-polar & rectangular, exponential and trigonometric forms, Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series-parallel circuits.

Unit-3: Transformers:

Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency, and voltage regulation.

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.

Unit-4: Three-Phase Induction Motors:

Concept of rotating magnetic field; Principle of operation, types and constructional features, Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Unit-5: Renewable Sources:

Sources of Electrical Power, Introduction to Wind, Solar, Fuel cell, Tidal, Geothermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation, Introduction to Earthing

TEXT BOOKS

Fundamental of Electric Circuits by Charles K Alexander and Matthew N. O.Sadiku, TMH Publication.

Electrical Engineering Fundamentals by Vincent Del Toro, PHI Publication.

Basic Electrical Engineering by V N Mittal & Arvind Mittal, TMH Publication.

Basic Electrical Technology by A.E. Fitzgerald, McGraw Hill Publication.

REFERENCE BOOKS

Kothari D P and Nagrath I J, “Basic Electrical Engineering “, Tata McGraw Hill, 1991

BASIC ELECTRONICS ENGINEERING	
Course Code: 24EC101/24EC201	**Continuous Evaluation:** 40 Marks
Credits: 3	**End Semester Examination:** 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To impart the knowledge of the passive and active electronic components
2. To understand the basic characteristics of Field Effect Transistors
3. To introduce the MOS devices
4. To gain knowledge of integrated circuit fabrication techniques
5. To introduce the digital logic gates and systems.
6. To understand the principle of microprocessors

COURSE LEARNING OUTCOMES (CLOs)

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

1. To learn the fundamental concepts of semiconductor devices
2. An ability to apply the concept of diode in clipper and clamper circuits
3. Acquire the skills of constructing the different transistor configurations
4. To learn the basic concepts of integrated circuits
5. To Compile the different building blocks in digital electronics using logic gates and implement simple logic functions using basic universal gates
6. To acquire the knowledge of microprocessors.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6
CO1	✓	✓				
CO2		✓				
CO3			✓	✓		

CO4			✓	✓		
CO5					✓	
CO6						✓

COURSE CONTENTS

Unit – 1: Semiconductor Diodes and Applications: p-n junction diode, Characteristics and Parameters, Half-wave rectifier, Full-wave rectifier, center tap and Bridge rectifier, and clipper, clamper, Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator and Numerical examples as applicable.

Unit –2: Bipolar Junction Transistor: Transistor Operation, Current Equation in n-p-n & amplifier; p-n-p transistors, CB, CE, CC Configurations and their Characteristics, Load line Analysis, BJT as Switch and amplifier, DC Biasing (Fixed bias and Voltage Divider), stability Factor.

Unit –3: Field Effect Transistor: JFET-types and their parameters, Operations, and their Characteristics, MOSFETs- types, Operations and their Characteristics, Secondary effects in MOSFET operation and Numerical.

Unit –4: Introduction to Operational Amplifiers: Ideal OPAMP, Inverting, and Non-Inverting OPAMP circuits, OPAMP applications: voltage follower, addition, subtraction, integration, differentiation; Numerical examples as applicable.

Unit –5: Digital Electronic Principles: Introduction, Binary digits, Logic levels and Digital waveforms, Introduction to basic Logic operation, Number system, Decimal numbers, Binary numbers, Decimal-to-Binary conversion, Simple binary arithmetic, Logic Gates, Boolean algebra and Combinational Logic Circuits: Boolean operations and expressions, Laws and Rules of Boolean algebra, DeMorgan's theorem, Boolean analysis of logic circuits, Standard forms of Boolean expressions, Boolean expression and truth table. Basic combinational logic circuits, Implementation of combinational logic, the universal properties of NAND and NOR gates, Half Adder adders, and full Adder.

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. Muthusubramanian.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

ENGINEERING MECHANICS	
Course Code: 23ME101/23ME201	**Continuous Evaluation:** 40 Marks
Credits: 3	**End Semester Examination:** 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To familiarize students with basic concepts of force and moments in equilibrium.
2. To impart students with the knowledge of mechanics for structural analysis.
3. To familiarize students with the centroids and MOI.
4. To make students aware of rigid body kinetics and kinematics.
5. 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:

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

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

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.

FRICTION:

• Introduction, Wet and Dry friction, Theory of Dry friction, Angle of friction, Angle of Repose, Cone of friction, Coulomb's laws of friction.

UNIT –II: 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

FUNDAMENTALS OF COMPUTER & C PROGRAMMING	
Course Code: 23CS101/23CS201	**Continuous Evaluation:** 40 Marks
Credits: 3	**End Semester Examination:** 60 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 analyse 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 the 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's that helps in developing of an application.
3. Apply and analyse the basic programming constructs in the context of the 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.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				

CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

UNIT-1: 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.

UNIT-2: 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.

UNIT-3 : BASICS OF 'C' LANGUAGE

C Fundamentals, Basic data types, variables and scope, operators and expressions, formatted input/ output, expressions, selection statements, loops and their applications.

UNIT-4: ARRAY & FUNCTION

Arrays, functions, recursive functions, pointers and arrays. Strings literals, arrays of strings; applications. Storage Classes and Pre-processor Directives.

UNIT-5 : STRUCTURE & FILE SYSTEM

Structures, Declaring a Structure, Accessing Structure Elements, Storing Structure Elements, Array of Structures, Unions and Enumerations.

File Input/Output, Data Organization, File Operations, Opening a File, Reading from a File, Closing the File, Writing to a File, File Opening Modes.

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, 2010, New Delhi.
4. Let Us C, Yashwant Kanetkar, 14th Edition, BPB Publications.
5. Computer Fundamentals and Programming in C, Reema Theraja, Oxford

REFERENCE BOOKS

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

COMMUNICATIVE ENGLISH	
Course Code: 24HS101/24HS201	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 0 0	
Prerequisite: Nil	

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 competence and boost their confidence.
3. To enable the students to properly communicate and express themselves in writing.
4. 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.
5. To study, understand and implement each unit according to National Education Policy 2020 and Bloom's Taxonomy.

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.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓	✓	✓		

CO2		✓		✓	
CO3			✓		
CO4				✓	✓
CO5					✓

COURE CONTENTS

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

Unit-II: Workplace Communication

- Communication Challenges in Culturally Diverse Workplace; Ethics in Communication, Bias-free communication
- Effective Business Presentations: Importance in workplace communication; Planning, Preparing, Organizing, Rehearsing, and Delivering Oral presentations, Handling Questions; and Power Point Presentation.

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 with respect to technical writing

Unit-IV: Business Writing at Work

- Cover Letters and Applications
- Writing notices and circulars

- Email Writing and Memorandum
- Writing reports

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.

HINDI -I	
Course Code: 24HIN-101- I	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 0 0	
Prerequisite: Nil	

Course Description:

विश्वविद्यालय ने वर्ष 2024-25 सत्र से स्नातक स्तर पर हिन्दी विषय का पाठ्यक्रम तैयार किया है। हिन्दी विषय के प्रश्न पत्र की सामग्री में ज्ञान तथा शिक्षा के बदलते परिदृश्य को ध्यान में रखा गया है। हिन्दी के भक्तिकाल, रीतिकाल और आधुनिक काल 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, भाषायी क्षमता एवम् अभिवृद्धि भी इस पाठ्यक्रम का लक्ष्य है।

(Course Content)

(Unit-A)

इस इकाई में हिंदी भक्तिकाल के प्रमुख कवि कबीरदास हैं।

कबीरदास- कबीरदास के दोहे (5 दोहे)

(Unit-B)

इस इकाई में हिंदी रीतिकाल के प्रमुख कवि बिहारीलाल हैं।

बिहारीलाल – दोहे (5 दोहे)

(Unit-C)

इस इकाई में हिंदी आधुनिक काल के प्रमुख कवि माखनलाल चतुर्वेदी हैं।

माखनलाल चतुर्वेदी- पुष्प की अभिलाषा (कविता)

(Unit-D)

यह इकाई संचार कौशल से सम्बन्धित है. इसमें

(i) हिंदी के प्रमुख मुहावरे और लोकोक्तियाँ

(ii) आत्म परिचय (self-introduction), साक्षात्कार कौशल (interview skills), कार्यक्रम संचालन/मंच प्रबंधन (event management)

Course Outcomes:-

पाठ्यक्रम परिणाम

(1.Knowledge Outcome)

1. ज्ञान का परिणाम

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

पाठ्यक्रम के अंत में छात्र सक्षम होना चाहिए

-हिन्दी क़े प्रमुख कवि जो पाठ्यक्रम में शामिल है, उनकी कविताओं की व्याख्या और काव्यगत विशेषताओं को छात्र समझेंगे ।

- छात्रों को काव्य में रस, अलंकार और छन्द का ज्ञान प्राप्त होगा|

-व्याकरण के अध्ययन से छात्रों को भाषा बोलने, लिखने और प पढने में सहायता प्राप्त होगी।

(2.Skill Outcome)

कौशल का परिणाम

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

पाठ्यक्रम के अंत में छात्र सक्षम होना चाहिए

-हिंदी कवियों व उनकी कविताओं से परिचित हो जाएंगे।

- छात्र दोहे और कविता समझने में सक्षम होंगे।

-व्याकरण के ज्ञान के साथ -साथ शब्दों के उच्चारण के बोध से अवगत होंगे।

(Methodology)

(पद्धति)

- कक्षा व्याख्यान

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

-समय-समय पर छात्रों को प्रदत्त कार्य दिया जाएगा |

-साप्ताहिक प्रश्नावली |

(Required Books and Materials)

आवश्यक पुस्तकें और सामग्री

-कबीर ग्रन्थावली, संपादक-श्यामसुन्दर दास, काशी नागरी प्रचारिणी सभा |

- बिहारी सतसई, साहित्य संस्थान प्रयाग|

-भाषा विज्ञान, डॉ. भोलानाथ तिवारी ,किताब महल इलाहाबाद |

-हिंदी व्याकरण, कामता प्रसाद गुरु, प्रभात प्रकाशन दिल्ली |

GERMAN-I	
Course Code: 24FLGR101- I	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 0 0	
Prerequisite: Basics of English Language	

COURSE OBJECTIVES (COs):

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.

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. Read and write short, simple texts.
2. Have Fluency in reading and writing.
3. Understand the dialogue between two native speakers and to take part in short, simple conversations using the skills acquired.
4. Know the culture of the countries where the German language is spoken.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓	✓	
CO3			✓	
CO4				✓

COURSE CONTENTS

UNIT 1: Information über Deutschland**,** Buchstaben, Regeln der Aussprache, Wochentage, Monate Grüße, sich vorstellen, Einige nützliche Ausdrücke des Alltagslebens, Zahlen bis 100

UNIT 2: Zahlen, Über Personen sprechen (Name, Herkunft, Adresse, Telefonnummer, Alter, Beruf, Familie)**,** Länder und Städte, Sprachen, Berufe, Bezeichnungen für Personen, Familienmitglieder**,** Personalpronomen, Konjugation von Verben (heißen, wohnen, kommen, machen, lernen, arbeiten, studieren, sein)

UNIT 3: Nomen (Genus, Singular-Plural), Bestimmter Artikel, Unbestimmter Artikel, Negation, W-Frage, Ja-Nein- Frage**:** Über Sachen sprechen**,** Sachen des Alltagslebens, Haushaltswaren, Adjektive, Gegenteile**,** Satz Struktur

UNIT 4: Akkusativ, Artikel und Personalpronomen im Akkusativ, Verben und Präpositionen mit Akkusativ, Konjugation und Verwendung von Verben (haben, kaufen, sehen, lieben, lesen, kennen, hören, verstehen, usw.)**,** Kleidung, Farben, Wetter, Lebensmittel

TEXT BOOKS:

1. Netzwerk Neu A1 (Kursbuch+Arbeitsbuch)
Dengler, Stefanie, et al. Netzwerk neu: A1. Ernst Klett Sprachen., 2019.

REFERENCE BOOKS:

1. Rusch, Paul, Helen Schmitz, and Humorvolle Zeichnungen. "Einfach Grammatik." *Übungsgrammatik Deutsch A1 bis B* 1 (2012): 329-330.Einfach Gramatik, Paul Rusch
2. Carlson, Antje. "Lemcke, Christiane, Lutz Rohrmann, and Theo Scherling. Berliner Platz 1 Neu--German for Beginners." *Die Unterrichtspraxis/Teaching German* 44.1 (2011): 46-49.
3. Dallapiazza, Rosa-Maria, Eduard Von Jan, and Sabine Dinsel. *Tangram: Deutsch als Fremdsprache. Lehrerbuch*. Vol. 1. Hueber Verlag, 1998.
4. Wolfgang Hieber: Lernziel Deutsch, Teil 1,Max HueberVerlag, 1984.

WEBSITE PAGES:

1. https://www.nthuleen.com/teach.html

FRENCH-I	
Course Code: 24FLFR101-I	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 0 0	
Prerequisite: Basics of English Language	

COURSE OBJECTIVE (COs)

1. To develop **listening, speaking, reading, and writing** requisites of a language.
2. To develop the ability **to construct sentences** and **frame questions**.
3. To equip the students with **cultural elements and communication strategies** that will help them **communicate in varied situations.**
4. To familiarize the students with the **French and Francophone culture.**

COURSE LEARNING OUTCOMES (CLOs)

1. After completion of this course, the student will be able **to express and interact in French** used in daily conversations.
2. The student will be able **to write short and simple texts.**
3. The student will be able to **initiate, understand and respond to the queries of cultural significance in various settings.**
4. The student can demonstrate **knowledge and understanding** of French and Francophone culture.

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

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓	✓	
CO3			✓	
CO4				✓

	Unités	Objectifs de Communication	Grammaire	Lexique
1	**La Salutation et l'Introduction**	Saluer. Entrer en Contact. S'Excuser. Remercier. Se Présenter/Présenter Quelqu'un.	Les Pronoms Personnels Sujets. L'Alphabet. Les Articles Indéfinis. Les Verbes en -ER au Présent.	Salutations, Les Nombres. Les Objets de la Classe. La Nationalité.
2	**On Partage des Renseignements**	Demander de Se Présenter Donner des Renseignements Personnels.	Etre et Avoir au Présent. Le Verbes en -ER au Présent. Les Adjectifs de Nationalités. L'Interrogation.	Les Adjectifs de Nationalité, Métiers et Secteurs Professionnels, L'Expression des Goûts et Intérêts
3	**Ma Ville et Mon Quartier**	Décrire et Qualifier une Ville ou un Quartier. Localiser. Demander et Donner la Directions.	Le Verbe Vivre. Les Articles Définis. Il y a/ Il n'y a pas. Les Prépositions. Les Adjectifs Qualificatifs. L'Impératif.	Les Prépositions de Localisation. Le Lexique des Sites. Etablissements et Service d'une Ville.
4	**Mes Intérêts et Goûts**	Parler de Ses Goûts et de Ses Loisirs. Donner Son Impression sur le Caractère de Quelqu'un.	Le Présent des Verbes en -ER, et du Verbe Faire. La Négation, Les Adjectifs Possessifs.	Avoir l'air. Loisirs. L'Expression des Goûts. Faire du/ de la Ma Famille.

ENVIRONMENTAL BIOENGINEERING	
Course Code: 23ESEB101/23ESEB201	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 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. Aim to introduce students to the different components of the environment.
3. To develop an 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 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.

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

CLO / 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 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.

Unit-2: 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 gardening.

Unit-3: 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.

Unit 4: 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.

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
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.
5. Principles of Biochemistry (V Edition) by Nelson, D.L; and Cox, M. M. W. H Freeman and company.

INDIAN CONSTITUTION & POLITY	
Course Code: 23VAC102/23VAC202	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 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.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓	✓	✓	
CO2		✓		✓
CO3			✓	✓
CO4				✓

COURSE CONTENTS

UNIT 1 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

UNIT 2 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

UNIT 3 LOCAL GOVERNMENT AND ADMINISTRATION: Panchayati Raj System, Rural and Urban administration, Social and Economic Justice for the marginalized, Directive Principles of State Policy

UNIT 4 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

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).

ENGINEERING PHYSICS LAB	
Course Code: 24AS152/24AS252	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES

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. Apply the analytical techniques and graphical analysis to the experimental data

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:

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

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3
CO1	✓	✓	
CO2		✓	
CO3			✓

LIST OF EXPERIMENTS

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

Experiment 1: To determine the moment of inertia of the disc and rigidity modulus of the wire by torsional pendulum.

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 the attenuation, numerical aperture and acceptance angle of the given optical fiber.

Experiment 5: To study the resonance characteristics of LCR series circuit.

Experiment 6: To determine Planck's constant.

Experiment 7: To study the I-V characteristics of a PN junction diode. **Experiment 8:** To determine the energy band gap by four-probe method.

Experiment 9: To determine the Hall coefficient of the given n-type or p-type semiconductor.

Experiment 10: To study the solar cell characteristic.

Experiment 11: To determine the dispersive power of a given prism.

Experiment 12: To determine the width of a single slit by diffraction.

Experiment 13: To study the characteristic of LDR and finding the dark resistance.

Experiment 14: To determine the acceleration due to gravity by bar pendulum.

Experiment 15: To verify the laws of vibration of string using sonometer.

Experiment 16: To study the resonance characteristics of LCR parallel circuit

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).

ENGINEERING CHEMISTRY LAB	
Course Code: 24AS153/24AS253	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

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 KMnO4 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 amount of sodium hydroxide and sodium carbonate in a mixture.
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.

BASIC ELECTRICAL ENGINEERING LAB	
Course Code: 23EE151/23EE251	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

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 (CLO)

The syllabus has been prepared in alignment with National Education Policy (NEP). After completion of 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

MAPPING BETWEEN COURSE OBJECTIVES AND COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓	✓		✓
CO2	✓			✓
CO3	✓	✓	✓	✓

COURSE CONTENTS

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.

BASIC ELECTRONICS ENGINEERING LAB	
Course Code: 24EC151/24EC251	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To study the different types of electronic components and equipment
2. To observe the characteristics of electronic devices
3. To acquire the basic knowledge of digital logic levels and application of knowledge

COURSE LEARNING OUTCOMES (CLOs)

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

1. Measure the voltage, frequency, and phase of any waveform using CRO.
2. Generate sine, square, and triangular waveforms with required frequency and amplitude using function generator.
3. Analyze the characteristics of different electronic devices such as diodes, transistors, and operational amplifiers
4. To develop skills to build and verify digital circuits.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓	✓		
CO2			✓	
CO3				✓

LIST OF EXPERIMENTS

1. (a). To study active and passive electronic components and function generators.

(b). To study the Digital Cathode Ray Oscilloscope (CRO) and operation of multi-meters.

2. Study of the V-I characteristics of P-N junction diode & Calculate DC & AC resistance.
3. Study of the V-I characteristics of Zener diode.

4. Construction of half-wave rectifier (with & without filter) and calculation of efficiency and ripple factor.

5. Construction of full wave rectifier circuits (with & without filter) and calculation of efficiency and ripple factor.

6. Design of inverting amplifiers using Op-Amp for a given gain with the help of a breadboard and distinct components.
7. Design of non-inverting amplifiers using Op-Amp for a given gain with the help of breadboard and distinct components.

8. Design of summer amplifiers using Op-Amp for a given gain with the help of a breadboard and distinct components.

9. Study of the input and output characteristics of Transistor.

10. Study and realization of digital logic gates with truth table verification

TEXT BOOKS

1. "Electronics Lab Manual", K.A. Navas ,Volume 1, Fifth Edition. 2015 by PHI Learning Private Limited, Delhi.

REFERENCE BOOKS

1. Electronic Devices and Circuit Theory - by Rober L. Boylestad 11th Edition, Pearson Publication, 2014
2. Millman J., Halkias C.C., Jit S., "Electronic Devices and Circuits", Tata McGraw-Hill, 2nd 2007 Edition

BASIC MECHANICAL ENGINEERING LAB	
Course Code: 23ME151/23ME251	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To acquaint students with the laws of parallelogram and equilibrium of forces acting on an object.
2. To make students understand the concepts and principles of friction.
3. To apply engineering sciences through learning-by-doing project work.
4. To provide a framework to encourage creativity and innovation. To develop team work and communication skills through group-based activity.

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 demonstrate:

1. The principle of equilibrium of forces and parallelogram.
2. The effects of friction on the motion.
3. The working and application of engineering components.
4. Develop group working, including task sub-division and integration of individual contributions from the team.

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

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1			✓	
CO2	✓			
CO3				✓
CO4		✓		

LIST OF EXPERIMENTS

1. To verify the law of parallelogram of forces.
2. To study the equilibrium of a body under three forces.
3. To find reaction at the supports of a simply supported beam with different types of loading using Computation method.
4. To determine the co-efficient of friction between wood and various surface (like Leather, Wood, Aluminum) on an inclined plane.
5. To study functioning of belt pulley systems.
6. To find the coefficient of friction between belt and pulley using belt pulley system.
7. To find forces in members of a truss for different load conditions.
8. To determine the mass moment of inertia of a rotating disc
9. To find center of gravity of different geometrical objects using computation method.
10. To verify the law of conservation of energy.
11. Demonstration for centrifugal forces.
12. Engineering Design Project- Students in groups of 4/5 will do a project related to the course.

Note: At least ***8 experiments*** must be carried out.

TEXT BOOKS

1. Laboratory Manual

REFERENCE BOOKS

1. Strength of Materials. Thimoshenko & Young
2. Engineering Mechanics: Statics and Dynamics, R. C. Hibbler, Pearson
3. Mechanics of Solids, A. Mubeen, Pearson

C PROGRAMMING LAB	
Course Code: 23CS151/23CS251	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 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 real world.
5. Employ good programming practices such as incremental development, data integrity checking and adherence to style guidelines.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES S(CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1			✓	
CO2	✓			
CO3				✓

CO4		✓		

LIST OF EXPERIMENTS

1. Write a program to find the largest of three numbers. (if-then-else)
2. Write a program to find the largest number out of ten numbers (for-statement)
3. Write a program to find the average mail height & average female heights in the class (input is in form of sex code, height).
4. Write a program to find roots of quadratic equation using functions and switch statements.
5. Write a program using arrays to find the largest and second largest no. out of given 50 nos.
6. Write a program to multiply two matrices.
7. Write a program to sort numbers using the sorting Algorithm.
8. Represent a deck of playing cards using arrays.
9. Write a program to check that the input string is a palindrome or not.
10. Write a program to read a string and write it in reverse order.
11. Write a program to concatenate two strings.
12. Write a program which manipulates structures (write, read, and update records).
13. Write a program which creates a file and writes into it supplied input.

Write a program which manipulates structures into files (write, read, and update records).

Note: At least 5 to 10 more exercises to be given by the teacher concerned.

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, 2010, New Delhi.

REFERENCE BOOKS

1. Let Us C, Yashwant Kanetkar, 14th 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.

MECHANICAL WORKSHOP LAB	
Course Code: 23ME152/23ME252	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. Study and practice on machine tools and their operations.
2. Practice on manufacturing of components using workshop trades including fitting,
3. To study basics of carpentry, foundry and welding.
4. Identify and apply suitable tools for machining processes including turning, facing.

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 different manufacturing (Fitting, carpentry, sheet metal, welding, smithy working etc.) processes required to manufacture a product from the raw materials.
2. Use different measuring, marking, cutting tools used in the workshop.
3. Be aware of the safety precautions while working in the workshop.

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

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓	✓	✓	
CO2	✓	✓	✓	
CO3	✓	✓		
CO4				✓

LIST OF EXPERIMENTS

Fitting Practice:

Use of hand tools in fitting, preparing a male and female joint of M.S. or making a paper weight of M.S.

Carpentry Practice:

Study of Carpentry Tools, Equipment and different joints.

Practice of Cross Half lap joint, Half lap Dovetail joint and Mortise Tenon Joint

Smithy

Tools and Equipments –Simple exercises base on smithy operations such as upsetting, drawing down, punching, bending, fullering & swaging, Making simple parts like hexagonal headed bolt, chisel

Welding Practice (Basic Theory to be explained prior to practice):

Gas Welding& Electric Arc welding Practice.

A joint such as a Lap joint, a T-joint or a Butt joint is to be prepared or to make furniture.

Machining (Basic Theory to be explained prior to practice):

(i) Stepped cylindrical Turning of a job and Thread-cutting in lathe. (ii) Shaping (iii) Milling

TEXT BOOKS

1. Laboratory Manual
2. Gopal, T.V., Kumar, T., and Murali, G., "A first course on workshop practice –Theory, practice and workbook", Suma Publications, 2005

REFERENCE BOOKS

1. Kannaiah,P. & Narayanan,K.C. —Manual on Workshop Practice", Scitech Publications, Chennai, 1999.
2. Venkatachalapathy, V.S. —First year Engineering Workshop Practice", Ramalinga Publications, Madurai, 1999

ENGINEERING GRAPHICS & DESIGN LAB	
Course Code: 23ME153/23ME253	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

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

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 orthographic projections of points and lines in any position through AutoCAD.
2. Imagine and convert isometric view into orthographic projections and vice versa.
3. Should be able to understand the simple machine components and draw its projections
4. Familiarize with projections of lines, planes, solids, isometric projections.

Mapping Matrix of Course Objectives (CO) and Course Learning Outcomes (CLO)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS:

	LIST OF EXPERIMENTS
	Introduction: **Auto CAD** Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning Line Conventions layout of the software, standard tool bar/menus and description of most commonly used toolbars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP &LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Coordinate points, axes, poly lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints. 2 – Sheets
	Orthographic Projections: Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only), True and apparent lengths, True and apparent inclinations to reference planes.2 – Sheets
	Orthographic Projections of Plane Surfaces (First Angle Projection Only): Introduction, Definitions–projections of plane surfaces–triangle, square, rectangle, rhombus, pentagon, hexagon and circle, planes in different positions by change of position method, **only 1-Sheet**
	Projections of Solids (First Angle Projection Only): Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions. 2-Sheets
	Sections and Development of Lateral Surfaces of Solids Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP. 2 – Sheet

		Isometric Projection (Using Isometric Scale Only): Introduction, Isometric scale, Isometric projection of simple plane figures, Isometric projection of tetrahedron, hexahedron(cube), right regular prisms, pyramids, cylinders, cones, spheres, cut spheres. 2-Sheets

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. Gopalakrishna, 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, New Delhi

REFERENCE BOOKS

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

COMMUNICATIVE ENGLISH LAB	
Course Code: 24HS151/24HS251	**Continuous Evaluation:** 60 Marks
Credits: 1	**End Semester Examination:** 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

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. 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.

MAPPING MATRIX OF COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓	✓	✓		
CO2		✓		✓	
CO3			✓	✓	
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1

- Listening and Speaking
- Practicing Sounds of English
- Accent in speech (British and American)

Unit-2

- Role-play
- Extempore
- Public Speaking and Rhetoric

Unit-3

- Presentations
- Interview Simulations
- Group Discussions and Debates

Unit-4

- Guided composition
- Free-writing
- Reading comprehension practice: Technical and General text

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,
2. Oxford University Press.
3. Communication skill by Sanjay Kumar & Puspa Lata, Oxford University Press. 2nd Edition.
4. Business Communication Today by Courtland L Bovee and Thill, Pearson

SEMESTER II

ELEMENTARY MATHEMATICS-II (For BME only)	
Course Code:24AS204	**Continuous Evaluation:** 40 Marks
Credits: 4	**End Semester Examination:** 60 Marks
L T P : 3 1 0	
Prerequisite: Elementary Mathematics-I	

COURSE OBJECTIVES (COs)

1. To introduce the concept of Differentiation of several variables.
2. To introduce the concept of Vector Calculus, Gradient, Divergence and Curl.
3. To introduce the concept of Second order differential equations and their applications.
4. To get the knowledge that illustrate the complex numbers.
5. To familiarize with the concept of complex variables.

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 differentiation of several variables.
2. Apply the knowledge of vector calculus in real life applications.
3. Apply the knowledge of Second order differential equations in solving simple problems.
4. Understand the complex number system and their uses.
5. Apply the knowledge to construct analytic functions.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Complex Numbers

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.

Unit-2: Successive Differentiation

Successive differentiation, n^{th} order derivatives of standard functions, Leibnitz theorem (without proof).

Unit-3: Differential Calculus of Several Variables

Introduction, Limit & Continuity, Partial derivatives, Homogeneous functions and Euler's theorem, Total derivatives, Jacobians, Properties of Jacobians.

Unit-4: Vector Calculus

Introduction, Scalar and vector point functions, differentiation formulae, Level surface, Gradient, Divergence, Curl, Directional derivatives, Simple Applications.

Unit-5: Linear Differential Equations

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.

TEXT BOOKS/ REFERENCE BOOKS

1. Grewal B.S, Higher Engineering Mathematics, Khanna Publications, 44th Edition, 2017.
2. Jain R. K., Iyengar S. R. K., "Advanced Engineering Mathematics", 6th Edition, Narosa Publishing House, 2019.
3. Bali N.P., Goyal M, Advanced Engineering Mathematics, Laxmi Publications, New, Delhi.2018.
4. Dass H. K., Advanced Engineering Mathematics, Sultan Chand Publication, Delhi, 2018.

HINDI-II	
Course Code:24HIN201-II	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 0 0	
Prerequisite: Nil	

LAGHU KATHAEN AUR SANCHAR KAUSHAL

Course Description:

विश्वविद्यालय ने वर्ष 2024-25 सत्र से स्नातक स्तर पर हिंदी विषय का पाठ्यक्रम तैयार किया है | हिंदी विषय के प्रश्न पत्र 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 होता है , इससे विद्यार्थियों की कल्पना शक्ति के विकास के साथ-साथ मनोरंजन भी होता है| संचार कौशल में मुहावरे, लोकोक्तियां, पत्र लेखन और अपठित गद्यांश की समझ के द्वारा हिंदी का प्रचार-प्रसार होगा| इस प्रकार साहित्य के ज्ञान की अभिवृद्धि वैश्वीकरण के संदर्भ में प्रासंगिकता और उपयोगिकता सिध्द करती है |

Course Content

(Unit-A)

इस इकाई में हिंदी लघु कथाओं का संक्षिप्त परिचय दिया गया है –

1 हिंदी लघु कथा का सामान्य परिचय |

2 हिंदी लघु कथा के प्रमुख प्रकार |

(Unit-B)

इस इकाई में हिंदी की दो लघु कथाएं सम्मिलित की गई हैं-

1 अंगूर की बेल

2. किसान और ठग

(Unit-C)

इस इकाई में हिंदी की दो लघु कथाएं सम्मिलित की गई हैं-

1 बुराई का फल

2 चार विद्वान ब्राह्मण

(Unit-D)

यह इकाई संचार कौशल से सम्बंधित है, इसमें

(i) प्रेस रिपोर्ट, विज्ञापन, अनुवाद

(ii) हिंदी पत्र लेखन और अपठित गद्यांश को समझना व तर्कसंगत उत्तर देना अपेक्षित है|

(Course Outcome)

पाठ्यक्रम परिणाम

(1.Knowledge Outcome)

1 ज्ञान का परिणाम

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

पाठ्यक्रम के अंत में छात्र सक्षम होना चाहिए

हिंदी लघु कथाओं के मूल उद्देश्य को समझने में विद्यार्थी निपुण हो जाएंगे| लघु कथाओं 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)

2 कौशल का परिणाम

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

-पाठ्यक्रम के अंत में छात्र सक्षम होना चाहिए

-हिंदी लघु कथाओं से मनोरंजन भी होगा |

-विद्यार्थी लघु कथाओं के मूल कथ्य को समझेंगे|

-विचार तत्व के बोध से अवगत होंगे|

-हिंदी में पत्र लेखन और अपठित गद्यांश को समझने में सक्षम होंगे |

(Methodology)

(पध्दति)

- कक्षा व्याख्यान

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

-समय-समय पर छात्रों को प्रदत्त कार्य दिया जाएगा|

-दैनिक प्रश्नावली|

(Required Books and Materials)

आवश्यक पुस्तकें और सामग्री

-पाठ्यक्रम में निर्धारित लघु कथाओं का संकलन |

-भाषा विज्ञान, डॉ. भोलानाथ तिवारी ,किताब महल इलाहाबाद |

-हिंदी व्याकरण, कामता प्रसाद गुरु, प्रभात प्रकाशन

GERMAN-II	
Course Code: 24FLGR201- II	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 0 0	
Prerequisite: Basics of English Language	

COURSE OBJECTIVES (COs):

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.

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. Read and write short, simple texts.
2. Have Fluency in reading and writing.
3. Understand the dialogue between two native speakers and to take part in short, simple conversations using the skills acquired.
4. Know the culture of the countries where the German language is spoken.

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

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

UNIT- 1

- Zeit-Ausdrücke, Tagesteile, Uhrzeit
- Präpositionen mit Akkusativ/Dativ, Ordinalzahlen
- Wegbeschreibung, Reisen, Verkehrsmittel
- Das Haus

UNIT- 2

- Modalverben
- Essen und Trinken, Mahlzeiten, Tagesablauf, Messeinheiten, Einkaufen
- Körperteile und Krankheiten
- Futur

UNIT- 3

- Dativ, Artikel und Personalpronomen im Dativ, Verben und Präpositionen mit Dativ, Konjugation und Verwendung von Verben (geben, kaufen, schenken, gratulieren, gehören, gefallen, gehen, fahren, fliegen, usw.)
- Possessiv-Artikel
- Trennbare Verben, Untrennbare Verben

UNIT 4

- Perfekt
- E- Mail Schreiben/ SMS Schreiben
- Vergangenheit erzählen, Das Wochenende, Lebenslauf

TEXT BOOKS :

- Netzwerk Neu A1 (Kursbuch+Arbeitsbuch)

Dengler, Stefanie, et al. Netzwerk neu: A1. Ernst Klett Sprachen., 2019.

REFERENCE BOOKS:

- Rusch, Paul, Helen Schmitz, and Humorvolle Zeichnungen. "Einfach Grammatik." Übungsgrammatik Deutsch A1 bis B 1 (2012): 329-330.Einfach Gramatik, Paul Rusch
- Carlson, Antje. "Lemcke, Christiane, Lutz Rohrmann, and Theo Scherling. Berliner Platz 1 Neu--German for Beginners." Die Unterrichtspraxis/Teaching German 44.1 (2011): 46-49.
- Dallapiazza, Rosa-Maria, Eduard Von Jan, and Sabine Dinsel. Tangram: Deutsch als Fremdsprache. Lehrerbuch. Vol. 1. Hueber Verlag, 1998.
- Wolfgang Hieber: Lernziel Deutsch, Teil 1,Max HueberVerlag, 1984.

WEBSITE PAGES:

- https://www.nthuleen.com/teach.html

FRENCH-II	
Course Code: 24FLFR201-II	**Continuous Evaluation:** 40 Marks
Credits: 2	**End Semester Examination:** 60 Marks
L T P : 2 0 0	
Prerequisite: French-I	

COURSE OBJECTIVE (COs)

1. To develop **listening, speaking, reading and writing** requisites of a language.
2. To develop the ability **to construct sentences** and **frame questions**.
3. To equip the students with **cultural elements and communication strategies** which will help them **communicate in varied situations.**
4. To familiarise the students with the **French and Francophone culture.**

COURSE LEARNING OUTCOMES (CLOs)

After completion of this course, the student will be able **to express and interact in French** used in daily conversations.

1. The student will be able **to write short and simple texts.**
2. The student will be able to **initiate, understand and respond to the queries of cultural significance in various settings.**
3. The student can demonstrate **knowledge and understanding** of French and Francophone culture.

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

Cos \ CLOs	CLO1	CLO2	CLO3
CO1	✓		
CO2		✓	
CO3			✓
CO4			

COURSE CONTENT				
S. No	**Unités**	**Objectifs de Communication**	**Grammaire**	**Lexique**
1	**Journée Typique**	Parler de Nos Habitudes, Exprimer l'Heure, S'Informer sur l'Heure, le Moment et la Fréquence.	Les Verbes Pronominaux au Présent. Les Verbes Aller et Sortir	L'Heure, Les Moments de la Journée. Les Activités Quotidiennes. Les Adverbs. La Météo.
2	**Achats**	S'informer sur un Produit. Acheter et Vendre un Produit. Donner Son Avis. Parler du Temps qu'il Fait	Les Adjectifs Interrogatifs. Les Adjectifs Démonstratifs Le Genre et le Nombre. Le Verbe Prendre.	Les Vêtements. Les Couleurs. Les Fruits et Les Légumes.
3	**Alimentation**	Parler des Plats et des Aliments. Commander un Menu dans un Restaurant. Situer une Action dans le Futur	Le Future Proche: Aller +Infinitif. Les Partitifs. Les Pronoms COD. Le Future.	Les Aliments. Le Lexique des Quantités.
4	**expérience vécue**	Parler de faits passés. Parler de Nos expériences. Parler de ce que nous savons faire.	Le Passé Composé. L'Imparfait.	Les Verbes Savoir, Pouvoir et Connaître. Les Adjectifs Qualificatifs. Le Lexique des Savoirs et Compétences. Le Récit de Vie.

TEXT BOOK

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

REFERENCE BOOKS

- Alter Ego 1, Livre d'élève, Berthet A. & Hugo C. & Kizirian M. V. & Sampsonis B. & Waendendries M., éd Hachette, Paris, 2006.

- Connexions 1, Loiseau Y. & Mérieux R., éd. Didier, Paris, 2004.

- Le Nouveau Sans Frontiers, Vol. 1, P. Dominique, J. Girardet et al, CLE International, Paris, 2013.

- Le Robert & Nathan Conjugation, Paperback, Le Robert Nathan, 2011

SEMESTER-III

Applications of Mathematics in Bio-Medical Engineering	
Course Code: 24MA301	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE EDUCATIONAL OBJECTIVES (CEO)

1. To familiarize the students with concepts of Fourier series.
2. To familiarize the students with partial differential equations and their solutions.
3. To describe Laplace and inverse Laplace transforms with their properties.
4. To gain good knowledge in the application of Fourier Transform.
5. To demonstrate understanding Z transform.

COURSE LEARNING OUTCOME (CLO)

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

1. Demonstrate Fourier series in engineering applications.
2. Elaborate different types of partial differential equations.
3. Apply Laplace transforms to find the solution of initial value and boundary value problems.
4. Apply and analyze Fourier transforms with different applications.
5. Evaluate the problems using z-transforms.

MAPPING MATRIX BETWEEN COURSE EDUCATIONAL OBJECTIVES AND COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENT

UNIT I- Fourier series

Periodic functions, Fourier Series, Dirichlet's Conditions for a Fourier Series, Fourier Series of discontinuous functions, Even and Odd functions, Half-range series (Period 0 to π), Change of Interval and Functions having arbitrary Period, Half-period Series, arseval's Formula, Practical Harmonic Analysis.

UNIT II- Partial Differential Equations

Introduction, Partial Differential Equations, Order, Method of Formation of Partial Differential Equations, Solution of Equation by Direct Integration, Lagrange's Linear Equation of first order. Solution of Linear Partial Differential Equations with Constant Coefficients.

UNIT III- Laplace Transforms

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, Simple Applications of Laplace transforms for solving IVP.

UNIT IV- Fourier Transforms

Introduction, Linear Property, Shifting Property, Change of Scale Property, Modulation Theorem, Fourier Transform of Derivatives, Fourier transform of Integrals, Fourier Transform of Dirac-Delta Function, Fourier Cosine Transform, Fourier Sine Transform, Fourier Sine and Cosine Transforms of Derivatives, Finite Fourier cosine Transform, Finite Fourier sine Transform, Convolution Theorem , Parseval's Identity (without proof)-applications.

UNIT V- Z – Transform

Introduction, Definition of Z- transform, Linear property , Frequency Shifting , First Shifting, Second Shifting, Differentiation in z-domain, Initial and Final value theorems, Convolution theorem, Z-transforms of basic functions, Inverse Z – transform using partial fraction and long division methods. Simple applications of Z – transform to difference equations.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Grewal B.S., Higher Engineering Mathematics, 44th Edition, Khanna Publishers, 2019
2. Raisinghania, M.D., Advanced Differential Equations, S. Chand Publishing, 2018

3. Ramana B.V., Higher Engineering Mathematics, TMH, New Delhi, 11^{th} reprint, 2010.

REFERENCE BOOKS

1. R.V. Churchill and J. Brown.: "Fourier Series and Boundary Value Problems" McGraw-Hill Book Company 8^{th} Edition-2017.
2. E. Kreyszig, Advanced Engineering Mathematics, Wiley-India, 10^{th} Edition, 2017.

TRANSDUCERS AND BIOSENSORS	
Course Code: 24BM301	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO):

1. To get the basic idea of measurements and the errors associated with measurement.
2. To gain knowledge on functioning of the various measuring instruments, display devices and application on the biomedical devices.
3. To know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
4. To study the different kind of biosensors with their applications.
5. To study about MEMS and designing of smart sensors.
6. To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.

COURSE LEARNING OUTCOMES (CLO):

1. Understand various measurement devices and techniques, including the underlying biological processes that generate the quantities to be measured or controlled.
2. Explain different display and recording devices for various applications.
3. Analyze the characteristics of different transducers.
4. Have a broad understanding of the applications of various sensors and transducers available for physiological and cellular measurements.
5. Get the clear domain knowledge about various measurement systems includes different types of sensors, electrodes, signal conditioning circuits for acquiring and recording various physiological parameters.
6. Be capable of critically reviewing the literature in the application area and apply knowledge gained from the course to analyse simple biosensing and transduction problems.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6
CO1	✓					
CO2		✓				
CO3			✓		✓	
CO4				✓	✓	
CO5					✓	
CO6						✓

COURSE CONTENTS

Unit I Measurement System

Measurement System – Instrumentation, Amplifiers and its types in biomedical, electrodes and transducers, Display And Recording Devices: CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor Application In Medicine

Unit II Transducers Principles & Medical Applications

Classification of transducers, characteristic of transducers, Temperature transducers: Resistance temperature detector (RTD), Thermistor, Thermocouple, Displacement transducers: potentiometer, resistive strain gauges, inductive displacement, capacitive displacement transducer, Pressure transducer: variable capacitance pressure transducers, LVDT transducers, strain gauge transducers, semiconductor transducers, catheter tip transducers, Piezoelectric transducer, Photoelectric transducers: photo- emissive tubes, Flow transducers: magnetic, resistive and ultrasonic.

Unit 3 Biopotential Electrodes

Electrode electrolyte interface, polarizable and non-polarizable electrodes, Electrode-skin Interface and Motion Artifact, Body-Surface Recording Electrodes, Internal Electrodes: Needle & wire electrodes, Electrode Arrays, Microelectrodes: Metal supported metal, micropipette (metal filled glass and glass micropipette electrodes), microelectronic, properties of microelectrodes. Electrodes for Electric Stimulation of Tissue (i.e., for ECG, EMG & EEG)

Unit 4 Chemical Biosensors

Blood gas and Acid-Base Physiology, Electrochemical sensors, reference electrode, pH, pO_2, pCO_2 electrodes, Ion-Selective Field-Effect Transistor (ISFET), Non-invasive Blood-Gas Monitoring, Blood-Glucose Sensors. Transcutaneous arterial oxygen tension & carbon dioxide tension monitoring enzyme electrode.

Unit 5 Optical Biosensors & MEMS

Principles of optical sensors, optical fiber sensors, indicator mediated transducers, optical fiber temperature sensors, Gas-ionization chamber, Geiger counters, Scintillation detectors, Sensors / receptors in the human body, basic organization of nervous system-neural mechanism, Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immunosensors, Basic principles of MOSFET biosensors & BIOMEMS, basic idea about Smart sensors.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2. S.C. Cobbold, "Transducers for Biomedical Instruments", Prentice Hall.
3. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
4. Rao & Guha, "Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.

REFERENCE BOOKS:

1. Leslie Cromwell, Fred J. Weibell, Erich .A Pfeiffer ``Biomedical Instrumentation and Measurements" second Edition published by PEARSON Education.
2. Marc Madou, Fundamentals of Microfabrication, CRC press 1997.
3. Stephen D. Senturia, Micro system Design, Kluwer Academic Publishers,2001.
4. Carr & Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.
5. Harry Thomas, "Handbook of Bio medical Instrumentation", Reston, Virginia.
6. D. L. Wise, "Applied Bio Sensors", Butterworth, London.
7. Doebelin E.O. and Manik D.N., "Measurement Systems", Tata McGraw-Hill Education Pvt. Ltd., 6th Edition, 2011.

HUMAN ANATOMY & PHYSIOLOGY	
Course Code: 24BM302	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination:60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES:

1. Understand basic human body functions and life processes.
2. Familiarize the concepts of cardiac and nervous systems.
3. Gain knowledge about functions of respiratory and musculoskeletal systems.
4. Understand the structure and functions of digestive systems and excretory systems.
5. Attain the knowledge about ear, eye and endocrine systems.

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:

1. Describe the fundamentals of human anatomy and physiology.
2. Makes a comparison and contrast between living and non-living things.
3. Describe the major structures that make up the human body.
4. Explain the physiology of digestive systems, respiratory, musculoskeletal, and excretory systems.
5. Classify distinct types of tissue to explain the anatomy and physiology of the skeletal system, ear, eye and endocrine systems.

MAPPING MATRIX OF COURSE OBJECTIVES and & COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓	✓			
CO2		✓	✓		
CO3			✓	✓	
CO4			✓	✓	

CO5					✓

COURSE CONTENTS

Unit I: Structure and function of Cell & cellular components:

Define Anatomy, Terms of Location, Position and Planes, Cell structure, Cell membrane Transport, Resting membrane potential and ionic basis of potentials, Action potential in nerve, Muscle and Heart, basic tissue and functions, outline of body structure

Unit II: Cardiovascular system and respiratory system:

Blood composition, functions of blood, functions of RBC.WBC types and their functions Blood groups, importance of blood groups, identification of blood groups. Blood vessels, Structure of heart, Properties of Cardiac muscle, Conducting system of heart, Cardiac cycle, Heart sound, Volume and pressure changes and regulation of heart rate, Coronary Circulation, ECG, Respiratory System: Components of respiratory system, Respiratory Mechanism, Types of respiration, Oxygen and carbon dioxide transport and acid base regulation.

Unit III: Musculo skeleton and special sensory system

Skeletal system: Bone types and functions, Axial Skeleton and Appendicular Skeleton. Joint, Types of Joint, Cartilage structure, types and functions.

Special Sensory system- Eye, Ear and Skin, Muscle Tissue, Structure of Skeletal Muscle, Types of Muscle, Types of Bones, Structure and Composition of Bone, Classification of Joints, Structure of Synovial Joint, Cartilage, Tendon, Ligament.

Unit IV: Digestive and Excretory System

Organization of GI system, Digestion and absorption, Movement of GI tract, Liver, Intestine, Pancreas, Role of Enzymes in Digestion, Function of kidney, structure of Nephron, Urine formation (Filtration, reabsorption and secretion) Counter – current system of urine concentration, Anomalies in urine concentration.

Unit V: Nervous System, Endocrine and Reproductive System

Structure of a Neuron, Types of Neurons, Neuroglial Cells, Synapses and types. Brain, Divisions of brain lobes, Cross Sectional Anatomy of Brain, Cortical localizations and functions, Spinal cord, Tracts of spinal cord, Spinal Nerve, Reflex mechanism, Types of reflexes. Autonomic nervous system and its functions. Mention of Endocrine glands general hormonal action (Pituitary, Thyroid, Parathyroid, Adrenal, Pancreas), Second messengers, testis, ovaries, Fallopian tube, Uterus.

TEXT BOOKS/REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Ross & Wilson Anatomy and Physiology in Health and Illness by Anne Waugh MSc CertEd SRN RNT FHEA and Allison Grant BSc PhD RGN | Jul 11, 2018.
2. Human Anatomy & Physiology (Marieb, Human Anatomy & Physiology) Standalone Book 10th Edition by Elaine N. Marieb & Katja Hoehn.
3. Concise Medical Physilogy – New Central Book agency7th edition by Sujit K. Chaudhuri.
4. Sobotta Atlas of Human Anatomy, Package, 15th ed., English: Musculoskeletal system, internal organs, head, neck, neuroanatomy by Friedrich Paulsen , Jens Waschke , et al. 25 June 2013.

REFERENCE BOOKS:

1. Gray's Anatomy for Students International Edition, 4e by Drake, 2019.
2. Textbook of Medical Physiology – Prism Book (p) Ltd 8^{th} edition by Arthur. C. Guyton.
3. A textbook of Practical physiology – 5th Ed Jaypee Medical Publishers, by CL. Ghai, 2003.
4. Clinical Anatomy: Applied Anatomy for Students and Junior Doctors by Harold Ellis and Vishy Mahadevan, 2018.

BIOCHEMISTRY

BIOCHEMISTRY	
Course Code: 24BM303	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO):

1. To understand biomolecules, their structure, composition and function.
2. To understand the underlying mechanism of cellular respiration.
3. To understand the metabolism of biomolecules.
4. To understand the basic concepts of bioenergetics.

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:

1. Student will be able to understand the structure, composition and function of protein, carbohydrate, lipids and nucleic.
2. Student will be able to understand the glycolysis, Kreb cycle, electron transport and photosynthesis.
3. Student will be able to understand the anabolism and catabolism of macromolecules.
4. Student will be able to understand the principles of thermodynamics and its application in living organisms.

MAPPING MATRIX OF COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2	✓	✓		
CO3			✓	✓
CO4				✓

COURSE CONTENTS

Unit I: Introduction to Biochemistry

Introduction-Chemical Bonds-pH-Buffers-Carbohydrates-Lipids-Proteins.

Unit II: Introduction to Metabolism

Glycolysis-Citric acid cycle-Gluconeogenesis-Glycogen metabolism,Glycogenesis-Glycogenolysis-Biochemical aspects of Diabetes Mellitus

Unit III: Protein Metabolism

Introduction-Metabolism of amino acids-Transamination-Deamination-Metabolism of ammonia-Urea cycle- Biosynthesis of amino acids-Disorders of tyrosine (phenylalanine) metabolism.

Unit IV: Fatty acid metabolism and Nucleic acid Metabolism

Introduction-Fatty acid oxidation-Ketone bodies & Ketogenesis-Biosynthesis of Fatty acids-Eicosanoids-Cholesterol Biosynthesis-Lipoproteins-Disorders of Lipid metabolism-Nucleic acids: Biosynthesis of Purine and Pyrimidines-Degradation of purine nucleotides and pyrimidine nucleotides-Disorders of Purine and pyrimidine metabolism.

Unit V: Oxidative Phosphorylation

Introduction-Bioenergetics, High energy compounds, Biological oxidation-Electron transport chain, Oxidative phosphorylation, Chemi-osmotic theory – Shuttle pathways – Glycerol phosphate Shuttle, Malate aspartate, Shuttle –Shunt pathways.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Jain, J L, Jain, Nitin, Sunjay Jain, S. Chand Group "Fundamentals of Biochemistry".
2. Satyanarayana & U. Chakrapani, "Biochemistry" Books and Allied (p) Ltd.
3. Principles of Biochemistry by Nelson, Cox and Lehninger.
4. Biochemistry by G. Zubay
5. Biochemistry by Stryer

REFERENCE BOOKS:

1. Jeremy M. Berg, John L. Tymoczko, LubertStryer, “Biochemistry” Edition 7, W. H. Freeman.

2. Biochemistry by Garrett and Grisham

3. Biochemical Calculations, Irwin H. Segel, 4.Biochemistry, DVoet and jGVoet , J Wiley Sons

5. Biochemistry, D Freifilder, W.H. Freeman & Company

TRANSDUCER AND BIOSENSOR LAB	
Course Code: 24BM351	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: NIL	

LAB OBJECTIVES (LO):

1. To study about the characteristics, working and applications of various devices in the field of bio sensors and transducers.
2. To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
3. To study the characteristics of sensors, signal conditioning circuits and display devices.
4. To familiarize the students with the operation of a few transducers having biomedical applications.
5. To provide experience on design, testing, analysis of some electronic circuits having application in biomedical equipment.
6. To introduce different cell potential methods.

LAB LEARNING OUTCOMES (LLO):

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

1. Design and understand characteristics and calibration of various transducers.
2. Students can design a measurement system for various applications.
3. Understand various read out and display devices.
4. Students will able to learn various transducers as Potentiometer transducer, Strain Gauge, LVDT.
5. Able to design various sensors with application in biomedical equipment and critically evaluate sensor and transducer options for a particular biomedical application.
6. Explain the different diagnostic methods for identification of human bio-potentials and their necessary instrumentation.

MAPPING MATRIX OF LAB OBJECTIVES AND LAB LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6
CO1	✓					
CO2		✓	✓			
CO3			✓	✓		
CO4				✓		
CO5					✓	
CO6						✓

LIST OF EXPERIMENTS

1. Measurement of waveform, amplitude, durations and frequency using CRO, triggering of beam with an external signal.
2. Demonstration of optics of simple microscopes, illustrations and function.
3. Calculation of magnification.
4. Demonstration of various types of transducers and their maintenance.
5. Study of Characteristics of Various Temperature Sensors

   a) Thermistor
   b) Thermocouple
   c) P- n Junction Diodes & Transistors
6. Study & characterization of bio-transducers – Pressure, Temperature, Humidity.
7. Study the displacement versus output voltage characteristics of a potentiometric transducer.
8. Study the characteristics of piezoelectric transducer.
9. Study & characterization of bio-electrodes for ECG.
10. Study & characterization of bio-electrodes for EMG.
11. Study & characterization of bio-electrodes for EEG.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Departmental Lab reference manual.

2. R. S. Khandpur, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill.
3. S.C. Cobbold, “Transducers for Biomedical Instruments”, Prentice Hall.

REFERENCE BOOKS:

1. Leslie Cromwell, Fred J. Weibell, Erich. A Pfeiffer ``Biomedical Instrumentation and Measurements” second Edition published by PEARSON Education.
2. Harry Thomas, “Handbook of Bio medical Instrumentation”, Reston, Virginia.

BIOCHEMISTRY LAB	
Course Code: 24BM353	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: NIL	

LAB OBJECTIVES (LO):

1. To understand the pH and titration of amino acids.
2. To understand reactions of amino acids, sugars and lipids.
3. To understand Quantitation of proteins and sugars.
4. To understand analysis of oils- iodine number, saponification value, acid number.

LAB LEARNING OUTCOMES (LLO):

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

1. The titration of amino acids.
2. Reactions of amino acids, sugars and lipids.
3. Quantitation of proteins and sugars.
4. Analysis of oils- iodine number, saponification value, acid number.

MAPPING MATRIX OF LAB OBJECTIVES & LAB LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

LIST OF EXPERIMENTS

1. Titration of amino acids.
2. Reactions of amino acids, sugars and lipids.
3. Quantitation of proteins and sugars.
4. Analysis of oils- iodine number, saponification value, acid number.
5. Organic Preparations –

a) p-nitrophenyl acetate

b) An aromatic alpha- and beta-glucoside starting with glucose

c) Dinitrophenyl hydrazone of ascorbic acid or any other ketone

d) Dinitrophenyl derivative of an amino acid

6. Qualitative and Quantitative Analysis of –

a) Carbohydrates

b) Amino acids and proteins

c) Free and bound phosphate

d) Vitamin C

7. Fats: Acid number, saponification, and iodine values.
8. Fractionation of egg proteins and its quantification.
9. Isolation of casein from milk and its quantification.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Departmental Lab reference manual
2. Biochemistry by Stryer

REFERENCE BOOKS:

1. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, “Biochemistry” Edition 7, W. H. Freeman.

SEMESTER-IV

INTRODUCTION TO PYTHON PROGRAMMING

Course Code: 24BM401	Continuous Evaluation: 70 Marks
Prerequisite: NIL	End Semester Examination:30 Marks
L T P : 0 0 2	
Credits: 1	

TRAINING OBJECTIVES (CO)

1. To understand the fundamental structure of Python programs and the installation process.
2. To demonstrate proficiency with Python data types, variables, control statements, and debugging techniques.
3. To develop and test functions, including the use of identifiers, keywords, and various operators.
4. To create Python programs incorporating input/output statements and built-in data structures.
5. To apply Python programming concepts to implement a functional contact management system.

TRAINING LEARNING OUTCOMES (TLOS)

After the completion of TRAINING the students will be able to:

1. Outline the basic structure of a Python program and discuss its components.
2. Practice variable assignments, perform operations with integers and floats, and utilize control statements effectively.
3. Design and implement functions, using appropriate identifiers, keywords, and operators.
4. Write programs that take user input and display output, utilizing built-in data structures like strings, lists, sets, tuples, and dictionaries.
5. Develop a functional contact management system incorporating all learned concepts, demonstrating comprehensive Python programming skills.

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

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5

CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

TRAINING CONTENTS

MODULE	TRAINING CONTENT	STUDENTS ENGAGEMENT ACTIVITY
I	Introduction to Programming using Python: Structu of a Python Program, Python Overview, Modes Programming in Python, installing Pytho Algorithms and Flowcharts.	Divide students into sma groups and ask them to outli the basic structure of a Pyth program. Each group presen their structure, and the cla discusses similarities a differences.
II	Data Types & Variables: Statements & Expression Variables, Integers & Floats. Control statements:-branching, looping, Ex function, break, continue and pass, mutable a immutable structures. Testing and debugging program.	Demonstrate variab assignment, operations wi integers and floats, and contr statements (if-else, loops Students will practice thes concepts by writing and testi simple code snippets.
III	Functions, Interpreter shell, Indentation. Identifie and keywords, Literals, Basic operators (Arithmet operator, Relational operator, Logical or Boole operator, Assignment Operator, Bit wise operator).	Students will design a implement their own function including defining paramete and return values. They will te their functions and u

	Building blocks of Python: Standard libraries i Python, notion of class, object and method.	identifiers, keywords, ar operators appropriately withi their functions.
IV	Creating Python Programs: Input and Output Statements Built-in data structures: Strings, Strings Slicing, lists, Sets, Tuples and Dictionary and associated operations, Indexing & Slicing.	Students will write a small program that takes user input and displays output, incorporating built-in data structures (strings, lists, sets, tuples, dictionaries) and using custom modules. For example a simple contact management system or a quiz game.
V	Hands on Activity: • Apply Python programming concepts: da types, control statements, functions, and da structures. • Implement a functional contact manageme system.	Implement a python progra that includes all the concepts.

LEARNING RESOURCES

1. "Python Programming: A Modern Approach", Vamsi Kurama, Pearson
2. "PythonProgramming",Oxford,ReemaThareja,June2017
3. "Learning Python", Mark Lutz, Orielly
4. "Think Python", Allen Downey, Green Tea Press
5. "Python Cookbook" by David Beazley and Brian K.Jones
6. "Python for Data Analysis" by Wes McKinney

BIOMEDICAL INSTRUMENTATION	
Course Code: 24BM402	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Knowledge of transducers and sensors	

COURSE OBJECTIVES (CO):

1. Provide foundational knowledge of biomedical instrumentation systems, including classification, components, and design principles.
2. Equip students with skills for understanding and applying various cardiovascular, neuromuscular, and sensory measurement techniques.
3. Impart knowledge of electrical safety standards and protocols for medical equipment.
4. Familiarize students with advanced biomedical instruments, including oximeters and blood flow meters.
5. Enable students to design, implement, and troubleshoot biomedical instrumentation systems in healthcare scenarios.

COURSE LEARNING OUTCOMES (CLO):

1. Describe fundamental concepts, classifications, components, and design considerations of biomedical instrumentation systems.
2. Measure and interpret cardiovascular parameters, such as ECG, heart rate, pulse rate, blood pressure, temperature, and respiration rate.
3. Conduct and analyze measurements from neuromuscular systems, including EMG, EEG, nerve conduction studies, and galvanic skin response.
4. Explain and apply the principles and usage of advanced biomedical instruments, including different types of oximeters and blood flow meters.
5. Understand and implement patient safety protocols, including classification of medical devices, risk mitigation for leakage currents, and designing safety circuits.

MAPPING MATRIX OF COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5

CO1	✓	✓			✓
CO2		✓			
CO3					
CO4				✓	
CO5			✓		✓

COURSE CONTENTS

Unit 1: Introduction to Biomedical Instrumentation: Introduction and classification of biomedical instrumentation systems, Components and design considerations of a biomedical instrumentation system, Desirable characteristics in designing biomedical instrumentation systems, Performance parameters of instruments, Frequency and amplitude ranges

Unit 2: Cardiovascular Measurement Systems: Description of human heart, cardiac cycle, ECG and Einthoven's triangle, 3 lead ECG system, Measurement of heart rate, pulse rate, blood pressure, temperature, and respiration rate, Apnea detectors, Heart rate variability measurement

Unit 3: Neuromuscular Systems: Description of the human brain, Origin and characteristics of EMG, EMG measurement and recording, Block diagram description of EMG systems, Evoked potentials, Electroencephalogram (EEG), EEG – 10-20 electrode system, Nerve conduction studies (NCS), Biofeedback instrumentation, Galvanic skin response (GSR) measurements

Unit 4: Oximeters and Blood Flow Meters: Principles of oximetry, Types of oximeters: Ear, Pulse, Skin Reflectance, Intravascular, Electromagnetic Blood Flow Meters, Types of Electromagnetic Blood Flow Meters, Ultrasonic Blood Flow Meters, Laser Doppler Blood Flow Meter

Unit 5: Electrical Safety of Medical Equipment and Patient: Patient safety, Classification of medical devices and their safety standards, Leakage current, micro, macro shock, Different types of safety circuits for medical equipment, Measures to reduce shock hazards

Special techniques for measurement of non-electrical biological parameters:

Electrical Impedance Plethysmography (EIP), Photoplethysmography (PPGs), respirometers

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Principles of Medical Electronics and Biomedical Equipments: C Raja Rao and SK Guha, (University Press India Limited)

2. Biomedical Instrumentation and Measurements: R Anandanatrajan (Prentice Hall of India)

3. Medical instrumentation, Webster John, John Wiley and sons, New York.2003.

4. Bio medical Instrumentation and Measurements, Cromwell Leslie, Fred J. Weibell, Erich Pfeiffer, PHI, 2nd edition, 2004.

REFERENCE BOOKS:

1. Principles of Biomedical Instrumentation and measurement: Richard Aston (Merill Publishers)

2. Handbook of Biomedical Instrumentation: RS Khandpur (Tata Mcgraw Hill publishers)

3. Introduction to Biomedical Instrumentation: Mandeep Singh (Prentice Hall of India).

4. Principle of Applied Bio medical Instrumentation, Geddes L.A. and L.E. Baker, 3rd edition Wiley Interscience Publication, 1989.

5. Principles of Biomedical Instrumentation and Measurement, Richard Aston Merrill, Publishing Company, 1990.

LINEAR INTEGRATED CIRCUITS	
Course Code: 24BM403	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Knowledge of Basic Electronics	

COURSE OBJECTIVES (CO):

1. The purpose of learning the course on Integrated circuit design for bioinstrumentation for biomedical engineering students is to enable the students to understand the fundamentals of linear integrated circuits and to implement and study in relation to the various medical related applications.
2. To understand the concepts, working principles and key applications of linear integrated circuits.
3. To perform analysis of circuits based on linear integrated circuits.
4. To design circuits and systems for particular applications using linear integrated circuits.
5. Demonstrate the basic concepts and design of active filters and data converters.
6. Explain the theory and applications of linear circuits and IC based system.

COURSE LEARNING OUTCOMES (CLO):

1. Understand the fundamentals and areas of applications for the integrated circuits.
2. Analyze important types of integrated circuits.
3. Demonstrate the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical, practical & simulated results in integrated circuits.
5. Understand the concept of application of filters and converters with applications.
6. Ability to design linear circuits and develop linear IC based Systems.

MAPPING MATRIX OF COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6
CO1	✓					
CO2		✓	✓			
CO3			✓			

CO4				✓		
CO5				✓	✓	
CO6						✓

COURSE CONTENTS

Unit I Integrated Circuits

Classification, chip size and circuit complexity, Fundamentals of Monolithic IC technology, basic planar processes, Fabrication of a typical circuit, Active and passive components of ICs, Thin and thick film technology. OPERATION AMPLIFIER: basic information of Op-amp, ideal and practical Op-amp, Op-amp characteristics, 741 op-amp and its features, modes of operation-inverting, non-inverting, differential mode.

Unit II OP-AMP Applications

Basic application of Op-amp, instrumentation amplifier, V to I and I to V converters, log and antilog amplifiers, sample & hold circuits, Differentiators and Integrators, Comparators, Schmitt trigger, Multivibrator, Triangular wave generator.

Unit III Active Filters, Oscillators & Regulators

Introduction-Low pass and High pass filters- Design of first order Butterworth lowpass and high pass filters Band pass, Band reject and all pass filters- Oscillator types and principle of operation – RC, Wien bridge oscillators, triangular, saw-tooth, square wave and VCO- Introduction to voltage regulators, features of 723, Three Terminal IC regulators- DC to DC Converter- Switching Regulators- UPS, SMPS.

Unit IV Timers & Phase Locked Loops

Introduction to 555 timer, functional diagram, monostable, astable and Bistable operations and applications, Schmitt Trigger. PLL - introduction, block schematic, principles and description of individual blocks of 565-PLL applications, Analog and digital phase detectors.

UNIT V D-A and A- D Converters

Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, Different types of

ADCs - parallel comparator type ADC, counter type ADC, successive approximation ADC, dual slope

ADC and Sigma delta ADC. Biomedical applications of A/D and D/A Converters.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. D. Roy Chowdhury, "Linear Integrated Circuits" New Age International (p) Ltd, 2nd Ed., 2003.
2. Coughlin and Driscoll, "Operational amplifiers and Linear Integrated Circuits", Prentice Hall, 6th Edition, 2001.

REFERENCE BOOKS:

1. R.F. Coughlin & Fredrick F. Driscoll. Operational Amplifiers & Linear Integrated Circuits, PHI, 6th Edition, 2003

2. Ramakanth A. Gayakwad, Op-Amps & Linear ICs –PHI, 4th Edition 2004.

3. Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Mc Graw Hill Education, 3rd Edition, 2017.

BIOMEDICAL INSTRUMENTATION LAB	
Course Code: 24BM452	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: NIL	

LAB OBJECTIVES (LO):

1. To study about respiratory rate measurement.
2. To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
3. To study the characteristics of ECG, EEG and EMG.
4. To familiarize the students with the oximetry.
5. To introduce spectrophotometer.

LAB LEARNING OUTCOMES (LLO):

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

1. Design and understand characteristics and calibration spirometer.
2. Students can design a measurement system for various applications.
3. Understand various methods to measure heart, muscles and brain signals.
4. Able to design various oximeter for a particular biomedical application.
5. Explain the spectrophotometer with its application in analysis.

MAPPING MATRIX OF LAB OBJECTIVES (LOs) AND LAB LEARNING OUTCOMES (LLOs):

LO/LLO	LLO1	LLO2	LLO3	LLO4	LLO5
LO1	✓				
LO2		✓	✓		
LO3			✓	✓	
LO4				✓	
LO5					✓

LIST OF EXPERIMENTS

1. Realization of pulmonary function analyzer using spirogram.
2. To study oximeters.
3. Measurements of various time intervals between each segment of ECG, Measurement of R-R interval and calculation of Heart Rate.
4. Determination of Heart Axis by measuring QRS amplitude in the different leads(Lead I, Lead II and Lead III) and Plotting Einthovin Triangle.
5. To study the EMG biofeedback system.
6. To determine Bradycardia and Tachycardia using ECG Training Kit.
7. To determine heart rate using ECG simulator Kit.
8. Realization of single beam / double beam.
9. Realization of spectrophotometer.

10. Study on autoanalyzer / cell counter/Blood gas analyzer.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL COURSES

TEXT BOOKS:

1. Departmental lab reference manual
2. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.

REFERENCE BOOKS:

1. Leslie Cromwell, Fred J. Weibell, Erich. A Pfeiffer ``*Biomedical Instrumentation and Measurements*" second Edition published by PEARSON Education.

LINEAR INTEGRATED CIRCUITS LAB	
Course Code: 24BM453	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: NIL	

LAB OBJECTIVES (LO):

1. To familiarize students with different Digital ICs corresponding to different logic gates.
2. To show the working operation of Filters.
3. To familiarize students with the design of OP AMPs circuits.
4. To familiarize students with the design of voltage regulators and Timer.
5. Design methodologies using practical integrated circuits.

LAB LEARNING OUTCOMES (LLO):

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

1. Understand and describe Digital ICs of different logic gates.
2. Describe, design and analyze Filters.
3. Describe, design and analyze OP AMPS circuits.
4. Use of timers and counters.
5. Understand the fundamentals and areas of applications for the Integrated Circuits.
6. Analyze important types of integrated circuits of day-to-day requirements.

MAPPING MATRIX OF LAB OBJECTIVES & LAB LEARNING OUTCOMES:

LO/LLO	LLO1	LLO2	LLO3	LLO4	LLO5	LLO6
LO1	✓					
LO2		✓				
LO3			✓			
LO4				✓		
LO5					✓	✓

LIST OF EXPERIMENTS

1. OP AMP Applications – Adder, Subtractor, Integrator and Differentiator Circuits using IC 741.
2. Active Filter Applications – LPF, HPF (first order)
3. IC 741 Oscillator Circuits – Phase Shift and Wien Bridge Oscillators.
4. Function Generator using OP AMPs.
5. IC 555 Timer – Monostable and Astable Operation Circuit.
6. IC 565 – PLL Applications, IC 566 – VCO Applications.
7. Voltage Regulator using IC 723.
8. Three Terminal Voltage Regulators – 7805, 7809, 7912.
9. 4 bit DAC using OP AMP.

TEXT BOOKS/REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Departmental lab reference manual
2. Coughlin and Driscoll, "Operational amplifiers and Linear Integrated Circuits", Prentice Hall, 6th Edition, 2001.

REFERENCE BOOKS:

1. R.F. Coughlin & Fredrick F. Driscoll. Operational Amplifiers & Linear Integrated Circuits, PHI, 6th Edition, 2003

SRM UNIVERSITY, DELHI – NCR, SONEPAT, HARYANA

DEPARTMENT OF BIOMEDICAL ENGINEERING

LIVE PROJECT

INTRODUCTION

Live Project provides an exposure to biomedical engineering industries/hospitals and develops the knowledge skills in real time industrial projects. It provides students to expand their knowledge and capabilities in specific area/subject while also allowing them to try out different jobs, and explore different career alternatives. The internship enables the students to understand and learn the current trends in the job market. Students will able to identify the problems in common biomedical industries/hospital equipments and provide a suitable solution, therefore outline the importance of medical device based on the application.

DURATION OF LIVE PROJECTS&TIMING AND CREDITS

- LIVE PROJECT-I (4th Semester): 1 CREDIT

LIVE PROJECT OBJECTIVES (LPO)

LPO1: To expose students to the industrial/hospital environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.

LPO2: To provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.

LPO3: To exposure to the current technological developments relevant to the subject area of training and to identify the future perspective of human machine interface.

LPO4: To create conditions conducive to quest for knowledge and its applicability on the job.

LPO5: To learn to apply the technical knowledge in real industrial situations and gain experience in writing technical reports/projects.

LPO6: To expose students to the engineer's responsibilities and ethics and understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

LIVE PROJECT LEARNING OUTCOMES (LPLO)

LPLO1: Integration of the theoretical aspects learned in the classroom in to the practical world.

LPLO2: Learning new skills and supplement knowledge.

LPLO3: Practice communication and teamwork skills. Illustrate the future perspective of human machine interface

LPLO4: Makes a valuable addition to their resume.

LPLO5: An opportunity to get hired by the Industry/ organization

MAPPING MATRIX OF LIVE PROJECT OBJECTIVES & LIVE PROJECT LEARNING OUTCOMES:

INTERNSHIP PROJECT OBJECTIVES (LPO'S)	INTERNSHIP PROJECT LEARNING OUTCOMES (LPLO'S)				
	LPLO1	LPLO2	LPLO3	LPLO4	LPLO5
LPO1	✓	✓			
LPO2		✓	✓		
LPO3			✓	✓	
LPO4			✓	✓	✓
LPO5			✓	✓	✓
LPO6			✓	✓	✓

PROJECT IDENTIFICATION:

1. Faculty and student will identify the project relevant to the professional core courses studied by the students before the start of the Internship.
2. Student and faculty will have to narrow down the area of interest in coordination with the Industry Supervisor / Mentor from a broader area of discipline.
3. The industrial internships of 1 credit each will be conducted in 5^{th} semester and 7^{th} Semester, which will be the foundation for a student to carry out a Minor and Major Project in the 7^{th} and the 8^{th} semester respectively.
4. Data bank of the projects will be prepared by the department which shall be dynamic and would be updated on continuous basis.

S.No.	Broad Area of Discipline	Mentor Name and Domain

Some of the project areas are as follow:

Wheelchair technologies; Orthotics and Prosthetics; Sensorial Prosthetics; Rehabilitation Engineering Introduction & application; Hospital Management; Imaging Technologies; Algorithms Techniques; Troubleshooting of biomedical devices etc.

ALLOCATION OF PROJECTS:

1. Once the faculty and student has finalized the area of interest, the student(s) will be allotted the project keeping in view the socio-economic benefits of the same.

2. Student shall select faculty mentor based on their specialization.

UNIQUE SELLING POINTS

- Job opportunity in Biomedical core industry
- Real Time Experience in Biomedical Industry/Hospital Projects
- Knowledge Skill in Biomedical Specific Domain and work experience with Industry persons
- Biomedical Engineering solutions in a global, economic, environmental, and societal context.

- Implement the techniques, skills and modern engineering tools necessary for human welfares.

LEARNING FOR FACULTY

- Good internship projects would be identified by faculty on the basis of their analysis.
- Identified the projects to be allocated to the faculty individually/groupwise for analysing in depth and preparing the learning outcomes of the respective project.
- Faculty/group could be required to make presentation in a faculty workshop to be organized by department.
- Relevant experiences & lessons and learning outcomes may be identified by faculty for their relevant courses and may be used making the courses delivery with real life experience and illustration of the industry. It may also be used for updating the curriculum as and when required.

LIVE PROJECT 1

- Multi channel temperature monitor.
- Fiber optic transmission of biomedical parameters.
- Patient's BP level monitoring system
- Stethoscope designing
- Ultrasonic Object Detector
- Temperature and humidity meter
- Voltage regulator

GUIDELINES FOR THE STUDENTS

- Students can do any kind of projects based on their interests or subjects.
- Training in special skills on which the project will be developed.
- Mentors to help the students for minor and major projects of engineering.
- Project selected should be of specific area related to Biomedical Applications.
- Project should be completed in given period of time as it is time restricted

DO'S

- Keep area neat and free from unnecessary objects.

- Inspect all equipment for damage (cracks, defects, etc.) prior to use—do not use damaged equipment.
- Wear disposable hand gloves and lab apron during project work.
- Properly dispose of gloves, chemicals, broken glassware in any case)
- Store aprons, bags, and other personal items in designated areas.
- Be careful while handling any lab equipment.

DONT'S

- Do not remove any equipment from the lab.
- Never attempt to catch a falling object in lab.
- Turn off all equipments and lights when not in use.
- Never pour chemical waste into sink drains or wastebaskets.
- Never block access to exits or emergency equipment.

SEMESTER-V

ADVANCED BIOMEDICAL INSTRUMENTATION	
Course Code: 24BM502	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Knowledge of biomedical instrumentation	

COURSE OBJECTIVES (CO):

1. Understand the objectives, types, and mechanisms of patient monitoring systems, including hearing mechanisms and audiometers.
2. Gain knowledge on the principles and working of foetal and neonatal monitoring systems, including cardiotocography and non-stress test monitoring.
3. Learn to measure and analyze pulmonary function using various analyzers and respiratory gas analyzers.
4. Familiarize with the principles and applications of analytical instruments and automated drug delivery systems, including colorimeters, spectrophotometers, and infusion pumps.
5. Introduction to MEMS and Microsystems, their materials, fabrication technologies, structures, and applications in bio-MEMS.

COURSE LEARNING OUTCOMES (CLO):

1. Describe the objectives, types, and mechanisms of patient monitoring systems, and calibrate various audiometers.
2. Explain the principles and working of foetal and neonatal monitoring systems, including methods for monitoring foetal heart rate and labour activity.
3. Measure and analyze pulmonary functions using spirometry, pneumotachometers, and other pulmonary function analyzers.
4. Apply the principles and use of analytical instruments like colorimeters, spectrophotometers, and ELISA readers, and explain the workings of automated drug delivery systems.
5. Understand the materials, fabrication processes, and applications of MEMS and Microsystems, including their use in bio-MEMS.

MAPPING MATRIX OF COs & CLOs

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5

CO1	✓				
CO2	✓	✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENT

Unit 1: Patient Monitoring Systems: Objective of patient monitoring systems, Types of monitors: Cardiac, bedside, central, Computer-assisted patient monitoring systems, Mechanism of hearing, Measurement of sound, Basic Audiometer, Pure Tone Audiometer, Speech Audiometer, Bekesy Audiometer, Evoked Response Audiometry System, Calibration of Audiometers

Unit 2: Foetal and Neonatal Monitoring Systems: Basic principles and working of Foetal and Neonatal Monitoring Systems, Cardiotocograph and methods of monitoring foetal heart rate, Monitoring of labour activity, Incubator and infant warmer, Non-stress test monitoring

Unit 3: Pulmonary Function Analyzers: Pulmonary Function measurements, Spirometry, Pneumotachometers, Measurement of Volume, Pulmonary Function Analyzers, Respiratory Gas Analyzers

Unit 4: Analytical Instruments and Automated Drug Delivery Systems: Colorimeter, spectrophotometer, Auto Analyzer, Electrophoresis apparatus, Chromatography, ELISA concepts (direct and indirect), reader & washer, Blood cell counter (Coulter and Pico-scale), Blood gas analyzer principle, pH, pO2, and pCO2 Electrodes, Complete block diagram of Blood gas analyzer, Automated drug delivery systems: Infusion pumps, syringe and peristaltic pumps, Implantable infusion systems, and insulin pumps

Unit 5: MEMS and Microsystems: Typical MEMs and Microsystems, Materials for MEMS: Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers, Micromachining: photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA Fundamental of MEMS: Introduction, principles, fabrication technologies, MEMS structures, MEMS materials, sensing and application in bio-MEMS

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS

1. Principles of Medical Electronics and Biomedical Equipments: C Raja Rao and SK Guha, (University Press India Limited)

2. Biomedical Instrumentation and Measurements: R Anandanatrajan (Prentice Hall of India)

3. Medical instrumentation, Webster John, John Wiley and sons, New York.2003.

4. Bio medical Instrumentation and Measurements, Cromwell Leslie, Fred J. Weibell, Erich Pfeiffer, PHI, 2nd edition, 2004.

REFERENCE BOOKS

1. Principles of Biomedical Instrumentation and measurement: Richard Aston (Merill Publishers)

2. Handbook of Biomedical Instrumentation: RS Khandpur (Tata Mcgraw Hill publishers)

3. Introduction to Biomedical Instrumentation: Mandeep Singh (Prentice Hall of India).

4. Principle of Applied Bio medical Instrumentation, Geddes L.A. and L.E. Baker, 3rd edition Wiley Interscience Publication, 1989.

5. Principles of Biomedical Instrumentation and Measurement, Richard Aston Merrill, Publishing Company, 1990.

INTRODUCTION TO MATLAB	
Course Code: 24BM501	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To familiarize and understand MATLAB environment.
2. To understand basic MATLAB operation.
3. To get acquainted with the MATLAB programming skills.
4. To understand fundamentals of Bioinformatics tool box.
5. To understand and analyse the biological data handling and its 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. Familiarize with the fundamentals of MATLAB.
2. To make mathematical operations in MATLAB.
3. Apply MATLAB Programming to solve diverse problems.
4. Apply bioinformatics tool box modules efficiently.
5. Data handling in MATLAB and applications of various algorithms to solve real life problems.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					

					✓

COURSE CONTENTS

Unit-1: GETTING STARTED WITH MATLAB:

Introduction to MATLAB: getting into MATLAB, installation, Environment, Applications. Overview of MATLAB toolboxes, MATLAB variables: Creating variables: Overwriting variable, Error messages, Making corrections, Controlling the hierarchy of operations or precedence, Controlling the appearance of floating point number, Managing the workspace, Keeping track of your work session.

Unit-2: BASIC MATLAB OPERATIONS

Array operations: Matrix arithmetic operations, Array arithmetic operations; Solving Linear equations: Matrix inverse, Matrix functions, Basic plotting: overview, Creating simple plots, Adding titles, axis labels, and annotations, multiple data sets in one plot, Specifying line styles and colors, Matrix generation and manipulations: Entering a vector, Entering a matrix, Matrix indexing, Colon operator, Linear spacing, Colon operator in a matrix, Creating a sub-matrix, Deleting row or column, Dimension, Continuation, Transposing a matrix, Concatenating matrices, Matrix generators, Special matrices**.**

Unit-3: PROGRAMMING IN MATLAB

M-file scripts: Introduction, Examples, script side-effects, M-File functions: anatomy of M-File function, Input and output arguments; Input to a script file, Output commands, Control flow and operators: Introduction, Control flow: The ‘‘if...end’’ structure, Relational and logical operators, The ‘‘for...end’’ loop, The ‘‘while...end’’ loop, Other flow structures, Operator precedence.

Unit-4: BIOINFORMATICS TOOLBOX

Features and Functions, Applications, Data Formats and Databases, Sequence Alignments, Sequence Utilities and Statistics, Sequence Viewer App: explore Nucleotide Sequence, Protein Sequence; Use the Biological Sequence Viewer: investigate protein sequences, Compare Sequences Using Sequence Alignment Algorithm, View and Align Multiple Sequences.

Unit-5: BIOLOGICAL DATA HANDLING AND ANALYSIS

Data Import and Export: Import sequence data from public repositories and local file systems**,** Nucleotide Sequence Analysis: Calculate and interactively explore sequence statistics; calculate sequence properties; analyze motifs; design primers; find restriction enzymes, Protein and Amino Acid Sequence Analysis:

Calculate and interactively explore amino acid sequence statistics; calculate sequence properties; find cleavage enzymes, Sequence Alignment: Multiple, pairwise, and profile sequence alignments using dynamic programming algorithms; BLAST searches and alignments; standard and custom scoring matrices, Phylogenetic Analysis: Reconstruct, view, interact with, and edit phylogenetic trees; bootstrap methods for confidence assessment; synonymous and nonsynonymous analysis.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS:

1. Cerian Ruth Webb, Mirela Domijan, "Introduction to MATLAB for Biologists", Springer, 2019.
2. Rudra Pratap, "Getting started with MATLAB", Oxford University Press, 2009.
3. Gautam B. Singh, "Fundamentals of Bioinformatics and Computational Biology: Methods and Exercises in MATLAB" Springer, 2015.

REFERENCE BOOKS:

1. Stormy Attaway, "MATLAB: a Practical Introduction to Programming and Problem Solving", Elsevier, 2009.
2. Leonid Burstein, "MATLAB in Bioscience and Biotechnology", Woodhead Publishing Ltd, 2011.
3. S Nello Cristianini, Matthew W. Hahn, "Introduction to Computational Genomics: A Case Studies Approach", Cambridge University Press, 2007.
4. Sara Baase , "Computer Algorithms - Introduction to design and analysis", Pearson Education, 1998.

NPTEL RESOURCES:

1. Introduction to Programming in MATLAB
2. MATLAB Programming for Numerical Computation
3. Bioinformatics: Algorithms and Applications
4. Computational Systems Biology

MATLAB LAB	
Code: 24BM551	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Practical Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To acquaint the student with the fundamentals of MATLAB software.
2. to provide an introduction to the Bioinformatics toolboxes.
3. To provide overview of MATLAB applications in 2D and 3D plotting.
4. Students will get acquainted with applications of MATLAB in biomedical 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:

1. Handle the basic MATLAB operations.
2. Familiarize with Bioinformatics toolbox and its applications.
3. Able to handle and analyse the data using graphical systems.
4. Able to formulate stepwise implementation of a MATLAB script (from developing a pseudo-code to execute a successful bug-free code) for a given problem in Biological problem.

MAPPING MATRIX OF (COs) AND (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

LIST OF EXPERIMENTS

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

1. Introduction to MATLAB Environment
2. Introduction to Bioinformatics Toolbox
3. Basic MATLAB Operations
4. Using M-Files and operations of M-files
5. To determine the Nucleotide composition
6. To determine the Codon Composition
7. To determine the Open Reading Frames.
8. Analyze the following operations in MATLAB.

   a) Colon operator b) Line Plotting c) 2D plotting
9. Sequence Analysis
10. Basics of Building a Phylogenetic Tree
11. Creating a Phylogenetic Tree for Five Species/ Twelve Species
12. Exploring and Visualization of Microarray Data

TEXT BOOKS:

1. Departmental MATLAB lab manual.

Advanced Instrumentation Lab	
Course Code: 24BM552	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: Biomedical instrumentation Knowledge	

LAB OBJECTIVES (LO):

1. To study about blood cell counter
2. To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
3. To study the working of hemodialysis machine and heart lung machine.
4. To study about pacemaker and defibrillator
5. To introduce audiometer

LAB LEARNING OUTCOMES (LLO):

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

1. Design and understand characteristics and calibration blood cell counter
2. Students can design a measurement system for various applications.
3. Understand working of various surgical instruments.
4. Able to understand pacemaker's types and defibrillator.
5. Explain the application of audiometer

MAPPING MATRIX OF LAB OBJECTIVES (LOs) AND LAB LEARNING OUTCOMES (LLOs):

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

LIST OF EXPERIMENTS

1. Blood Cell Counter
2. To study ELISA
3. Infusion Pump
4. Demonstration of working of heart lung machine
5. Hemodialysis Machine
6. Audiometer
7. Patient Monitor
8. Diathermy
9. Defibrillator Working
10. To study Pacemaker and pacemaker Stimulator.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL COURSES

TEXT BOOKS:

1Departmental lab reference manual

2R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.

REFERENCE BOOKS:

1. Leslie Cromwell, Fred J. Weibell, Erich. A Pfeiffer ``*Biomedical Instrumentation and Measurements*" second Edition published by PEARSON Education.

SEMESTER-VI

MEDICAL IMAGING AND ITS APPLICATIONS	
Course Code: 24BM601	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To understand the physics of image formation in medical imaging
2. To study the basics of biomedical instrumentation used in medical imaging
3. To grasp the mathematical concept of image reconstruction
4. To learn how to assess image quality in medical imaging

COURSE LEARNING OUTCOME (CLO)

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

1. To clear view on medical imaging and its physics
2. Clear understanding of image construction
3. To learn about Quality assurance and image improvement in diagnostic radiology with X- Rays
4. To learn about Development of NMR, relaxation processes and their measurements, MRI-Image

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENT:

UNIT I – INTRODUCTION

Introduction to medical imaging technology, systems, and modalities. Image properties: contrast and spatial resolution, digital image representation. Radiations: Electromagnetic spectrum, structure of atom, interaction of radiation with matter, biophotonics

UNIT II – X-RAY IMAGING

History and Properties of X-rays, attenuation of X-rays in tissue, quantification of X-rays- equivalent dose, effective dose, absorbed dose, patient-specific radiation risk estimation.

Radiology: Production of X-rays, X-Ray tubes and generators, Instrumentation of planar X-rays: collimators, anti-scatter grids, intensifier screens, and X-ray film, Computed and Digital Radiography. X-ray image characteristics. Radiography: angiography, fluoroscopy, and mammography. Introduction to C-ARM & Dental X-Ray.

UNIT III -TOMOGRAPHY

Principles of Computed Tomography, Image reconstruction theory: Radon Transform, Simple and Filtered Back Projection, and Iterative reconstruction. Hardware of CT. Spiral/helical computed tomography. Clinical applications of CT, CT angiography. PET and SPECT instrumentation and their clinical applications.

UNIT IV - ULTRASOUND IMAGING

Ultrasound physics, Physical characteristics of sound, Ultrasonic transducer and its component, characteristics of ultrasound beam, interaction of ultrasound and matter-quarter wave matching, Ultrasonic display imaging principles – B mode, M mode, Doppler mode – real time ultrasound, ultrasound instrumentation, bio effects, and safety considerations.

UNIT V - MAGNETIC RESONANCE IMAGING

Nuclear Magnetic Resonance: Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, rotating frame of reference, and the RF magnetic field. Generation and Detection of NMR Signal: The magnet (superconducting magnets, permanent magnets), magnetic field gradients, the NMR coil/probe, and data acquisition, Clinical applications of MRI, biological effects of MRI.

TEXT BOOK

1. “Radiographic Imaging”, Chesney & Chesney, Blackwell scientific publications, oxford (1981).
2. "Imaging for Students" David A. Lisle (Arnold).

REFERENCE BOOKS

1. “Radiographic imaging”-Derrick P. Roberts and Nigel L. Smith. Churchill Livingstone, Edinburgh (1994)
2. “Radiographic Latent image processing”, W.E.J. Mckinney
3. “Photographic processing, quality control and evaluation of photographic material”, J.E. Gray
4. “Physical and photography principles of Medical Radiography”, Seeman & Herman.
5. "MRI for Technologists", Peggy Woodward & Roger F. Freimark, McGraw Hill Publication

BIOMATERIALS AND ARTIFICIAL ORGANS

Course Code:24BM602	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Recognition about the different classes of materials used in medicine
2. To gain knowledge about the application of biomaterials in medicine
3. Contrast the concept of biocompatibility and the methods of biomaterial testing
4. Identify the technologies of biomaterial processing, clinical trials, ethical issues and regulatory standards.
5. Visualize the existing designs of artificial organs.

COURSE OUTCOMES (CLO)

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

1. Analyze different types of Biomaterials and its classification.
2. Perform combinations of materials that could be used as a tissue replacement implant.
3. Know about the various polymeric materials used for medical applications
4. About bio-ceramics and its applications in medicine
5. Applications and properties of materials in orthopedics.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

COURSE CONTENTS

UNIT- I BIOMATERIAL PROPERTIES

Biomaterial - definition, Material characterization – Mechanical, thermal, Phase diagrams, Surface properties, Causes of failure - micro cracks, crazing, fatigue. Technologies of biomaterials processing - Surface coating methods.

UNIT -II CLASSES OF BIOMATERIALS

Different classes of materials used in medicine - Polymers - Synthesis -Mechanical & Thermal properties Polyesters- Polyacrylates- Poly anhydrides - Biodegradable Polymers - Hydrogels – Elastomer - Dendrimers. Metals - Stainless steel - Cobalt- Chromium alloy - Titanium alloys. Ceramics and Bio glasses - non absorbable bio ceramics - biodegradable ceramics – bio reactive ceramics - deterioration of ceramics.

UNIT- III SOFT AND HARD TISSUE APPLICATIONS

Sutures, Wound dressings, artificial skin - Drug delivery devices- Cardiovascular medical devices, Orthopedic fixation devices – Internal – External - Joints, Total Hip Arthroplasty – Evolution-Design.

UNIT- IV MATERIAL RESPONSE

Material and Tissue interaction, biological environment and host response- Inflammation, Wound Healing and Foreign Body Response - Failure mechanisms; corrosion, fracture, degradation of Implanted Materials – Polymers, Metals, ceramics.

UNIT- V BIOMATERIAL TESTING AND ARTIFICIAL ORGANS

Sterilization Techniques: definition of sterilization, Types of sterilization: autoclaving, ETO and gamma radiation. Effects of sterilization on the properties of materials.

Testing of biomaterials: In-vitro, In-vivo preclinical tests - biocompatibility – methods for improvement. eye and ear implants, artificial pancreas, ophthalmic implantation, dental implantation, insulin administration devices, extracorporeal artificial organs, neural prostheses.

TEXT BOOKS:

1. Joon Bu Park, Roderic S. Lakes, "*Biomaterials*", Springer-Verlag, New York Inc., 2010.
2. Ratner B.D and Hoffman A.S, "*Biomaterials Science: An Introduction to Materials in Medicine"*, Academic Press; 3 edition, November 8, 2012.

REFERENCE BOOKS:

1. Chua P.K, Chena J Y, Wanga L.P, Huang N, "*Plasma-surface modification of biomaterials",* Materials Science and Engineering: R: Reports, Volume36, Number 5, 29 March 2002, pp. 143-206.
2. Sujata V. Bhat, 'Biomaterials', Narosa publishing house Pvt Ltd; 4th Edition, 2010.

MEDICAL IMAGING LAB	
Code: 24BM651	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Practical Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: NIL	

COURSE OBJECTIVE (CO)

1. To provide demonstration of various imaging instruments
2. Study the working and construction of X-Ray Machine
3. To introduce students with basic operation of tomography
4. Gain knowledge about measurements of parameters related to ultrasound

COURSE LEARNING OUTCOME (CLO)

1. Understand about working and construction of various imaging instruments
2. Deep understanding of X-Ray Machine
3. Understand & describe the basic operation of tomography
4. Knowledge about ultrasound

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

Cos \ CLOs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

LIST OF EXPERIMENTS

1. To study the construction and working of X-Ray equipment.
2. Study of factors affecting the quality control of X-ray relating the dark room, cassettes & films used.
3. How the mA (milliamperes) and Kvolts of X ray affect its quality and how it should be monitored.
4. How to plan radiology Department, its power supply and dark room.
5. Maintenance of X-ray machine (its cooling filament)
6. Demonstration of CT scan-how is CT tube superior to X ray tube.
7. Demonstration of MRI.
8. Study of Probes/Transducers – its different frequencies and shapes.
9. Study various Ultrasound modes- A mode, B mode, AB mode, C mode and M mode.
10. Spatial filtering in Ultrasound Images & Speckle noise removal.
11. Hospital visits for various imaging modalities (X ray, CT, MRI and PET)

TEXT BOOKS:

1. Departmental Lab Manual
2. R. S. Khandpur, Handbook of biomedical Instrumentation, Tata McGraw Hill Publication company Ltd, New Delhi, 1997.

REFERENCE BOOKS:

1. Biomedical Engineering Handbook by J D Bronzino, CRC Press
2. Introduction to Biomedical Engineering by John D Enderle, Academic Press Series

BIOMATERIALS LAB	
Code: 24BM652	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Practical Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: NIL	

COURSES OBJECTIVES (CO)

1. Analysis of Mechanical properties of Biomaterials using destructive and non- destructive method.
2. Calculation of moment of inertia of human limb.
3. To study the biocompatibility of implantable materials.
4. To measure the conductivity, pH of body fluid.

COURSES LEARNING OUTCOMES (CLO)

1. Perform Mechanical characterization of biomaterials using destructive and non -destructive methods.
2. Measure Surface roughness
3. *invitro* haemo compatibility of biomaterials
4. Perform pH determination, viscosity and Conductivity measurement of anybody fluid.

MAPPING LAB OBJECTIVES & LAB LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	

CO5					✓

LIST OF EXPERIMENTS

1. Methods to improve properties of biomaterials. (CVD, PVD and Plasma Polymerization)
2. Structural quantification of biomaterials by X-Ray Diffraction (XRD)
3. Chemical analysis of biomaterials by X-Ray Photoelectron Spectroscopy (XPS)
4. In-Vitro testing of biomaterial Quantification of cellular responses for cell-biomaterial interaction
5. Designing of drug delivery system (dendrimers) for targeting a cancer site
6. In-vivo testing of implanted biomaterial
7. Electrospinning technique for biomaterial fabrication
8. 3D Bioprinting technique for fabricating artificial organs and tissues
9. Viscosity measurement of body fluid.
10. Conductivity measurement of body fluid
11. pH measurement of body fluid

TEXT BOOKS:

1. Department Lab manual
2. J B Park, *Biomaterials - Science and Engineering*, Plenum Press, 1984
3. Bronzino JD, ed. The Biomedical Engineering Handbook, Second Edition, Vol-II, CRC Press

REFERENCE BOOKS:

1. Jonathan Black, *Biological Performance of materials*, Marcel Decker, 1981
2. Piskin and A S Hoffmann, *Polymeric Biomaterials* (Eds), Martinus Nijhoff Publishers

SEMESTER- VII

BIOMECHANICS OF SOFT AND HARD TISSUES	
Course Code: 24BM701	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Understand physiologically relevant fluid, solid mechanics and the basic mechanical concepts involved in human movement.
2. Understand fluid and solid mechanics that are pertinent to blood flow in the heart and blood vessels.
3. Apply fluid mechanical analyses relevant to biomedical engineering problems.
4. Conduct fluid mechanical analyses of human circulation, primarily applied to blood flow at the arterial level.

COURSE LEARNING OUTCOME (CLO)

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

1. Understand the basic concepts of physiologically relevant fluid, solid mechanics and basic mechanical concepts.
2. Know about the applicability of fluid and solid mechanic in heart and blood vessels.
3. Know the fluid mechanical characteristics application in Biomedical Engineering
4. Knowledge of basic principles of fluid mechanics, and ability to analyze fluid flow problems with the application.

MAPPING MATRIX BETWEEN COURSE OBJECTIVES AND COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	

CO4				✓

COURSE CONTENT

UNIT I

Fluids and non-fluids, continuum coordinate systems, force and moments, stress at a point, rate of strain, properties of fluids, classification of fluids. Different types of fluid flows, laminar and turbulent flow, transition from laminar to turbulent flow, laminar flow-annulus, laminar flow between parallel plates, measurement of viscosity. Development of boundary layer, estimates of boundary layer thickness, boundary layer equation.

UNIT II

Nature of turbulence, smooth and rough surface, boundary layer separation. Friction loss in flow in a tube. Velocity distribution of aortic system, waveform of pressure and velocity in aorta, wave reflections and impedance in arterial segments, blood flow in veins and blood flow in capillaries. Control theory and system analysis, mechanical analysis of circulatory systems, basic concept of myocardial mechanics, index of contractibility, fluid dynamics of aortic and mitral valves.

UNIT III

Use of statics, kinetics – rigid and non rigid bodies – Forces and motion – Newtons laws – Moment of force – Static equillibrum – Centre of gravity – Stability of equilibrium - Steps in analyzing a biomechanical problem – Graphical methods – contact forces – resolution of forces.

UNIT IV

Skeletal joints, skeletal muscles, basic considerations, basic assumption and limitations, forces and stresses in human joints, mechanics of the elbow, shoulder, spinal column, hip, knee and ankle. Human locomotion, gait analysis and goniometry, Ergonomics, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Total Hip Prosthesis: requirements, different types of components, Stress analysis & instrumentation, Knee Prosthesis.

UNIT V

Mechanical properties of blood vessels – arteries, arterioles, capillaries, veins, physics of cardio vascular diseases, prosthetic heart valves and replacement. Alveoli mechanics, interaction of blood and lung, P-V curve of lung, breathing mechanism, airway resistance, physics of lung diseases.

TEXT BOOKS

1. K.L. Kumar, “Engineering fluid mechanics”, Eurasia Publishing House (P) Ltd., New Delhi, 1998.

2. Frank Bell, Principles of Mechanics and Biomechanics, Stanley Thorne (Publishers) Ltd., 1998

3. Donald R. Peterson and Joseph D. Bronzino, Biomechanics Principles and applications, CRC press, Taylor & Francis Group, LLC, 2008

4. Duane Knudson, Fundamentals of Biomechanics, Second Edition, Springer publication , 2007

REFERENCE BOOKS

1. D.H. Bergel, “Cardiovascular fluid dynamics”- Vol. I, Academic

MICROPROCESSOR AND MICROCONTROLLERS	
Course Code: 24BM702	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. Understand the fundamental concepts of 8085 and 8086 microprocessors
2. Explain the basic concepts of 8051 microcontroller
3. Familiarize about PIC microcontroller
4. Acquire knowledge on applications of microprocessor and microcontroller in biomedical domain.

COURSE LEARNING OUTCOMES (CLO)

1. Describe the 8085-microprocessor architecture, programming and its applications.
2. Elucidate the architecture and addressing modes of PIC microcontroller
3. Program the microcontrollers for a given application.
4. Hardware interfacing of PIC microcontroller and sensor interfacing to develop solutions of real world problems.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES (CO & CLO)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4			✓	✓

COURSE CONTENTS

UNIT I INTRODUCTION TO INTEL 8085

Evolution of Microprocessor - Architecture of 8085 - Instruction format - Addressing modes - Basic timing diagram of opcode fetch, memory read, memory write, I/O read and I/O write - Interrupts of 8085 - Software interrupts, Hardware interrupts, Priorities of interrupts8085 based system design.

UNIT II INTEL 8085 INTERFACING

Interfacing devices- 8255 Programmable Peripherals Interface- Architecture & various modes of operation - 8251 USART Architecture and programming features - 8237, DMA Controller Architecture & Programming features. Interfacing with ADC and DAC, LCD, keyboard Interface.

UNIT 3 INTRODUCTION TO 8086

Architecture of 8086 - Registers set of 8086 - Special function of general purpose register - Addressing modes of 8086 - Instruction set - pin diagram of 8086 - Timing diagram- memory read, memory write, I/O read and I/O write - Minimum and Maximum mode of operation Interrupts of 8086.

UNIT 4 MICROCONTROLLER

Introduction to 8 - bit Microcontrollers - 8051 Microcontroller Architecture - Registers set of 8051 - modes of Timer operation - Serial Port operation - Interrupt Structure of 8051 - Memory and Input / Output Interfacing of 8051.

UNIT 5 APPLICATIONS

Application of microprocessors: Stepper Motor Control, Temperature control, Interfacing EPROMs & SRAMs with 8085. Interfacing Biosignal to Microprocessor- block diagram.

TEXT BOOKS

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 4 th Edition, Penram International Publishing, New Delhi, 2000

2. Kennith J. Ayala, 8051 Microcontroller, Thomson, 2005.

3. Dougles V. Hall, Microprocessor and Interfacing, Tata MC Graw Hill Publication, 2nd Edition, 1992.

4. Charless M. Gilmore, “Microprocessor Principle and application, McGraw Hill publication, 1995.

REFERENCE BOOKS

1. A. Nagoor Kani, Microprocessor & Microcontroller, Tata Mc Graw Hill, 3rd Edition, 2012

2. B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, 2001.

MICROPROCESSOR AND MICROCONTROLLER LAB	
Course Code: 23BM752	**Continuous Evaluation: 60 Marks**
Credits: 1	**End Semester Examination: 40 Marks**
L T P : 0 0 2	
Prerequisite: Nil	

LAB OBJECTIVES (LO)

1. To make the students understand the basic programming of Microprocessor and microcontroller.
2. To interface the microprocessor / microcontroller with various peripherals for various applications
3. To prepare the students to be able to solve different problems by developing different programs.
4. To develop the quality of assessing and analyzing the obtained data.

LAB LEARNING OUTCOMES (LLO)

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

1. Identify relevant information to supplement to the Microprocessor and Microcontroller course.
2. Set up programming strategies and select proper mnemonics and run their program on the training boards.
3. Practice different types of programming keeping in mind technical issues and evaluate possible causes of discrepancy in practical experimental observations in comparison.
4. Develop testing and experimental procedures on Microprocessor and Microcontroller analyze their operation under different cases.
5. Prepare professional quality textual and computational results, incorporating accepted data analysis and synthesis methods, simulation software, and word-processing tools

MAPPING LAB OBJECTIVES & LABLEARNING OUTCOMES

LO/LLO	LLO1	LLO2	LLO3	LLO4	LLO5
LO1	✓				
LO2	✓	✓			
LO3			✓	✓	✓
LO4			✓	✓	✓

LIST OF EXPERIMENTS

1. To study the architecture of 8086 microprocessor and 8086 microprocessor kit
2. Write a program to add the contents of the memory location 3000:0400 H to the content of 4000:0700 H and store the result in 6000:0900 H
3. Write a program to add 16 bit number using 8086 instruction set.
4. Write a multiplication of two 16 bit number using 8086 instruction set.
5. Write a program for division of two 16 bit numbers using 8086 instruction set.
6. Write a program factorial of a number.
7. Write a Program to transfer a block of data with and without overlap.
8. Write a program to find the average of two numbers.
9. Write a program to find the sum of the first n integers.
10. Write a program to generate a square wave, rectangular wave and triangular wave.
11. Study Architecture of 8051 Microcontroller & Power on reset circuit.
    - (a) Write an assembly language program to add eight 8-bit numbers.
    - (b) Write an assembly language program to find average of eight 8-bit numbers.
12. Write an assembly language program to find a maximum number from a given 8-bit ten numbers.
13. Write an assembly language program to find a minimum number from a given 8-bit ten numbers.
14. Arrange the given ten 8-bit numbers in ascending order.
15. Design a mini project based on microcontroller.

TEXT BOOKS:

1. Departmental Lab Manual.

REFERENCE BOOKS:

1. A K Ray and K M Bhurchandi, "Advanced Microprocessors & Peripherals", 2nd ed., TMH, 2006.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, "The 8051 microcontroller and embedded systems", Pearson education, 2004

MINOR PROJECT	
Course Code: 23BM757	Continuous Evaluation: 60 Marks
Credits: 4	End Semester Examination: 40 Marks
L T P : 0 0 8	
Prerequisite: Nil	

MINOR PROJECT OBJECTIVES

MPO1: To expose students to the industrial/hospital environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.

MPO2: To provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.

MPO3: Exposure to the current technological developments relevant to the subject area of training and to identify the future perspective of human machine interface.

MPO4: To create conditions conducive to quest for knowledge and its applicability on the job.

MPO5: To learn to apply the technical knowledge in real industrial situations and gain experience in writing technical reports/projects.

MPO6: To impart the students to the engineer's responsibilities and ethics and understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

MINOR PROJECT LEARNING OUTCOMES

MPLO1: Integration of the theoretical aspects learned in the classroom in to the practical world.

MPLO2: Learning new skills and supplement knowledge.

MPLO3: Practice communication and teamwork skills. Illustrate the future perspective of human machine interface

MPLO4: Makes a valuable addition to their resume.

MPLO5: An opportunity to get hired by the industry/ organization

MAPPING MATRIX OF MINOR PROJECT OBJECTIVES & MINOR PROJECT LEARNING OUTCOMES:

MINOR PROJECT OBJECTIVES (MPO'S)	MINOR PROJECT LEARNING OUTCOMES (MPLO'S)				
	MPLO1	MPLO2	MPLO3	MPLO4	MPLO5
MPO1	✓	✓			
MPO2		✓	✓		
MPO3			✓	✓	
MPO4			✓	✓	✓
MPO5			✓	✓	✓
MPO6			✓	✓	✓

Some of the project areas are as follow:

Wheelchair technologies; Orthotics and Prosthetics; Sensorial Prosthetics; Rehabilitation Engineering Introduction& application; Hospital Management; Imaging Technologies; Algorithms Techniques; Troubleshooting of biomedical devices etc.

LIVE PROJECT IV AND INDUSTRIAL VISIT	
Course Code: 23BM759	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 1	
Prerequisite: Nil	

LIVE PROJECT OBJECTIVES

LPO1: To expose students to the industrial/hospital environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.

LPO2: To provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.

LPO3: Exposure to the current technological developments relevant to the subject area of training and to identify the future perspective of human machine interface.

LPO4: To create conditions conducive to quest for knowledge and its applicability on the job.

LPO5: To learn to apply the technical knowledge in real industrial situations and gain experience in writing technical reports/projects.

LPO6: To impart the students to the engineer's responsibilities and ethics and understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

LIVE PROJECT LEARNING OUTCOMES

LPLO1: Integration of the theoretical aspects learned in the classroom in to the practical world.

LPLO2: Learning new skills and supplement knowledge.

LPLO3: Practice communication and teamwork skills. Illustrate the future perspective of human machine interface

LPLO4: Makes a valuable addition to their resume.

LPLO5: An opportunity to get hired by the Industry/ organization

MAPPING MATRIX OF LIVE PROJECT OBJECTIVES AND LIVE PROJECT LO:

(LP/LPLO)	LPLO1	LPLO2	LPLO3	LPLO4	LPLO5
LPO1	✓	✓			
LPO2		✓	✓		
LPO3			✓	✓	
LPO4			✓	✓	✓
LPO5			✓	✓	✓
LPO6			✓	✓	✓

LIVE PROJECT IV:

1. X-ray timer circuit
2. Ultra sound transducer for distance measurement
3. Generation of signals using MATLAB
4. Sampling of the signals
5. Addition, subtraction and multiplication of the signals.
6. To find freq. response of the signal by using commands and formula.
7. Make a gaussian filter in MATLAB and used for different images.

MAJOR PROJECT (INDUSTRIAL INTERNSHIP)	
Course Code: 23BM857	Continuous Evaluation: 60 Marks
Credits: 12	End Semester Examination: 40 Marks
L T P : 0 0 24	
Prerequisite: Nil	

MAJOR PROJECT OBJECTIVES

MPO1: To expose students to the industrial/hospital environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.

MPO2: To provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.

MPO3: Exposure to the current technological developments relevant to the subject area of training and to identify the future perspective of human machine interface.

MPO4: To create conditions conducive to quest for knowledge and its applicability on the job. **MPO5:** To learn to apply the technical knowledge in real industrial situations and gain experience in writing technical reports/projects.

MPO6: To recognize the students to the engineer's responsibilities and ethics and understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

MAJOR PROJECT LEARNING OUTCOMES

MPLO1: Integration of the theoretical aspects learned in the classroom in to the practical world.

MPLO2: Learning new skills and supplement knowledge.

MPLO3: Practice communication and teamwork skills. Illustrate the future perspective of human machine interface

MPLO4: Makes a valuable addition to their resume.

MPLO5: An opportunity to get hired by the industry/ organization.

MAPPING MATRIX OF MAJOR PROJECT OBJECTIVES AND MAJOR PROJECT LEARNING OUTCOMES:

MAJOR PROJECT OBJECTIVES (MPO'S	MAJOR PROJECT LEARNING OUTCOMES (MPLO'S)				
	MPLO1	MPLO2	MPLO3	MPLO4	MPLO5
MPO1	✓	✓			
MPO2		✓	✓		
MPO3			✓	✓	
MPO4			✓	✓	✓
MPO5			✓	✓	✓
MPO6			✓	✓	✓

Some of the project areas are as follow:

Wheelchair technologies; Orthotics and Prosthetics; Sensorial Prosthetics; Rehabilitation Engineering Introduction& application; Hospital Management; Imaging Technologies; Algorithms Techniques; Troubleshooting of biomedical devices etc.

SEMESTER- VIII

MAJOR PROJECT (INDUSTRIAL INTERNSHIP)	
Course Code: 23BM857	Continuous Evaluation: 60 Marks
Credits: 12	End Semester Examination: 40 Marks
L T P : 0 0 24	
Prerequisite: Nil	

MAJOR PROJECT OBJECTIVES

MPO1: To expose students to the industrial/hospital environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.

MPO2: To provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.

MPO3: Exposure to the current technological developments relevant to the subject area of training and to identify the future perspective of human machine interface.

MPO4: To create conditions conducive to quest for knowledge and its applicability on the job. **MPO5:** To learn to apply the technical knowledge in real industrial situations and gain experience in writing technical reports/projects.

MPO6: To recognize the students to the engineer's responsibilities and ethics and understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

MAJOR PROJECT LEARNING OUTCOMES

MPLO1: Integration of the theoretical aspects learned in the classroom in to the practical world.

MPLO2: Learning new skills and supplement knowledge.

MPLO3: Practice communication and teamwork skills. Illustrate the future perspective of human machine interface

MPLO4: Makes a valuable addition to their resume.

MPLO5: An opportunity to get hired by the industry/ organization.

MAPPING MATRIX OF MAJOR PROJECT OBJECTIVES AND MAJOR PROJECT

LEARNING OUTCOMES

MAJOR PROJECT OBJECTIVES (MPO'S)	MAJOR PROJECT LEARNING OUTCOMES (MPLO'S)				
	MPLO1	MPLO2	MPLO3	MPLO4	MPLO5
MPO1	✓	✓			
MPO2		✓	✓		
MPO3			✓	✓	
MPO4			✓	✓	✓
MPO5			✓	✓	✓
MPO6			✓	✓	✓

Some of the project areas are as follow:

Wheelchair technologies; Orthotics and Prosthetics; Sensorial Prosthetics; Rehabilitation Engineering Introduction& application; Hospital Management; Imaging Technologies; Algorithms Techniques; Troubleshooting of biomedical devices etc.

SPECIALIZATION IN MEDICAL INSTRUMENTATION

ELECTRONICS DEVICES AND CIRCUITS

Course Code: 24BMP301	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO):

1. To introduce basic semiconductor devices, their characteristics and application.
2. To learn to analyze the PN junction behavior at the circuit level and its role in the operation of diodes and active device
3. To apply concepts for the design of Regulators and Amplifiers.
4. To understand the operation of the various bias circuits of BJT, Analyze and design MOSFET bias circuits.
5. To Learn the operation and design of multistage amplifier for a given specification
6. To study oscillators and power amplifiers using transistor

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:

1. Understand the current voltage characteristics of semiconductor devices
2. Ability to analyze PN junctions in semiconductor devices under various conditions.
3. Design and analyze simple BJT circuits.
4. Design amplifier circuits and apply negative feedback principle to amplifier stages.
5. Understand the specifications of regulators and power supply circuits.
6. Capability to differentiate between different Oscillators and amplifiers for biomedical applications.

MAPPING MATRIX OF COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CO/CLO	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6
CO1	✓	✓				
CO2		✓				
CO3			✓			
CO4				✓		
CO5					✓	
CO6						✓

COURSE CONTENTS

UNIT- I JUNCTION DIODE CHARACTERISTICS

Review of semi-conductor Physics – n and p –type semi-conductors, Mass Action Law, Continuity Equation, Hall Effect, Open-circuited p-n junction, The p-n junction as a rectifier (forward bias and reverse bias), The current components in p-n diode, Law of junction, Diode equation, Energy band diagram of p-n diode, Volt-ampere characteristics of p-n diode, Temperature dependence of V-I characteristic, Transition and Diffusion capacitances, Breakdown Mechanism in Semi-conductor Diodes, Zener diode characteristics.

UNIT- II JUNCTION TRANSISTOR, BIASING AND STABILIZATION

Transistor Current Components, Transistor as an amplifier, Configurations of Transistor (CE, CC, CB), Emitter Follower circuit, BIASING AND STABILISATION: DC Operating Point- DC equivalent model-Criteria for fixing operating point- Methods of Bias stabilization: fixed bias, emitter bias, voltage divider bias, Bias Stability, Stabilization against variation in Ico, VBE and Beta, Bias Compensation. BJT as Switch.

UNIT- III RECTIFIERS, FILTERS AND REGULATORS

Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit, Inductor filter, Capacitor filter, L- section filter, π- section filter, Multiple L- section and Multiple π- section filter and comparison of various filter circuits in terms of ripple factors, clippers, clampers, voltage multipliers. Simple circuit of a regulator using Zener diode. Series and Shunt voltage regulators- Analysis and design- Protection circuits for voltage regulators.

UNIT IV SPECIAL SEMICONDUCTOR DEVICES

Tunnel diode and characteristics- PIN diode- Varactor diode- Schottky diode- Gunn diode- Laser diode- photo conductive sensors- photo voltaic sensors- Light Emitting Diode (LED)- Avalanche Photo diode, Charge coupled device (CCD)- Silicon Control Rectifier (SCR)- two transistor equivalent, Applications of SCR, Unijunction Transistor (UJT).

UNIT-V AMPLIFIERS

Small signal low frequency transistor amplifier circuits: h-parameter representation of a transistor, Analysis of single stage transistor amplifier using h-parameters: voltage gain, current gain, Input impedance and Output impedance. –Temperature compensation using diode biasing, thermistor and sensitor compensation, Thermal run away-Thermal stability,

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. J. Millman, C. C. Halkias, and Satyabratha Jit, "Electronic Devices and Circuits" Tata McGraw Hill, 2nd Ed., 2007.
2. A. L Malvino & D. P. Leach, "Digital Principles and applications" TMH.
3. A.P. Malvino, "Electronics Principals" TMH 3rd Ed.
4. David A. Bell, "Electronic Devices and Circuits", Prentice Hall of India, 5th Edition, 2008.
5. Sedra and Smith, "Microelectronic circuits", Oxford University Press, 7th Edition, 2014.

REFERENCE BOOKS:

1. R.L. Boylestad and Louis Nashelsky, Electronic Devices and Circuits, Pearson/Prentice Hall, 9th Edition,2006.

2. P. Ramesh Babu, "Electronic Devices and Circuits" Scitech Publications Pvt, Ltd., 2008

3. Nagrath, ""Electronic Devices and Circuits" PHI Learning, 2006.

4. Muhammad H. Rashid, "Microelectronic Circuits: Analysis and Design", Cengage Learning, 6th Edition, 2013.

5. Thomas L. Floyd, "Electronic devices" Prentice Hall", 10th Edition, 2018.

6. Donald A Neamen, "Electronic Circuit Analysis and Design", Tata Mc Graw Hill, 4th Edition, 2009.

7. Robert L. Boylestad, "Electronic Devices and Circuit Theory", 11th Edition, 2015.

8. Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, 2004.

ANALOG AND DIGITAL COMMUNICATION	
Course Code: 24BMP302	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO):

1. The objective of the course is to make the students familiar with detailed description of communication system.
2. To Familiarize with concepts of AM, FM and PM Techniques.
3. The course is providing the understanding of different Pulse Modulation Techniques.
4. Understanding of obtaining the modulated signal by using different techniques.
5. To provide in depth knowledge of transmitter and receiver design in digital communication and biomedical applications.

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:

1. Ability to formulate and interpret the presentation and processing of signals in Communication Systems.
2. Knowledge of concepts of transmission and reception of AM, FM, PM Transmission and Reception.
3. Capability to evaluate different Pulse Modulation Techniques.
4. Ability to access and evaluate different types of Modulators and Demodulators.
5. Ability to analyze the performance of baseband and passband digital communication systems along with biomedical applications.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES (CO & CLO)

CO/CLO	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURE CONTENTS

Unit-I

Introduction: Need for modulation, frequency translation and demodulation in communication systems - Basic scheme of a modern communication system.

Unit-II

Analog Modulation Techniques: Amplitude modulation: Derivation of expression for an amplitude modulated wave. Carrier and side band components. Modulation index. Spectrum and BW of AM Wave. Relative power distribution in carrier and side bands. Frequency modulation - Expression for frequency modulated wave and its frequency spectrum (without Proof and analysis of Bassel function) Modulation index, maximum frequency deviation and deviation ratio, BW of FM signals, Carson's rule. - Effect of noise on FM carrier. Noise triangle, Role of limiter, Need for pre-emphasis and de-emphasis, capture effect. - Comparison of FM and AM in communication system.

Unit-III

Analog Modulation and Pulse Modulation Techniques: Phase modulation - Derivation of expression for phase modulated wave, modulation index, comparison with frequency modulation. Statement of sampling theorem and elementary idea of sampling frequency for pulse modulation - Basic concepts of time division multiplexing (TDM) and frequency division multiplexing (FDM) - Pulse Amplitude Modulation (PAM), Pulse Position Modulation (PPM), Pulse Width Modulation (PWM).

Unit-IV

Introduction: Digital Communication

Introduction to Digital Communications, Nyquist Sampling Theorem, Information Sources, Random process, Quantization, Pulse Code Modulation, Multichannel and multicarrier systems: of DM.

Unit-V

Base Band Transmission

Line Coding and its properties, Various types of PCM waveforms, M-ary Pulse Modulation waveforms, Multiplexing PCM Signals, Delta Modulation, Idling Noise and Slope Overload, Adaptive Delta Modulation, Adaptive DPCM, Comparison of PCM and DM. Biomedical Applications of Communication Engineering.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Principles of Communication Engineering by Manoj Kumar, Satya Prakashan, New Delhi
2. Principles of Communication Engineering by Anokh Singh, S. Chand and Co., New Delhi
3. Principles of Communication Engineering by Roody , Coolen, Pearson Publisher
4. T. M. Cover and J. A. Thomas, "Elements of Information Theory," Wiley Student Edition, 1999, Reprint 2009.
5. U. Madhow, "Fundamentals of Digital Communication," Cambridge Univ. Press, 2008.

REFERENCE BOOKS:

1. Electronics Communication System by Kennedy, Tata McGraw Hill Education Pvt Ltd, New Delhi.
2. Principles of Communication Engineering by Taub, Tata McGraw Hill Education Pvt Ltd.
3. Electronics Communication by KS Jamwal, Dhanpat Rai and Co, New Delhi.
4. Radio Engineering by GK Mittal, Khanna Publishers, New Delhi.
5. B.P. Lathi and Z. Ding, "Modern Digital and Analog Communication Systems," 4^{th} Ed., Oxford University Press, 2009.

HOSPITAL SAFETY & MANAGEMENT

Course Code: 24BMP401	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO):

1. To study dynamics of disease transmission;
2. To learn Changing pattern of diseases;
3. To familiarize with Concept of health & disease and well-being;
4. To apprentice the strategic management in hospitals.

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:

1. Learn the fundamentals of hospital management;
2. Recognize the value of human resource management;
3. Know the information management systems and their applications;
4. Understand the safety protocols followed in hospitals.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CO/CLO	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS

UNIT-I

Clinical engineering program, educational responsibilities, role to be performed by them in hospital, staff structure in hospital – HIS. Need for evolving health policy, health organization in state, health financing system, health education, health insurance, health legislation

UNIT -II

Difference between hospital and industrial organization, levels of training, steps of training, developing training program, evaluation of training, wages and salary, employee appraisal method.

UNIT -III

Necessity for standardization, FDA, AERB, Joint Commission of Accreditation of hospitals, ICRP and other standard organization, methods to monitor the standards.

UNIT -IV

Nature and value of strategic management in hospitals, Introduction to support services - Disaster management, Ambulance services, laundry services, Civil Assets etc. Hospital engineering & Management: Definition of biomedical Engineering, clinical engineering & hospital engineering. Importance of BME department – servicing and maintenance, testing, acceptance & maintenance protocols, Computerized preventive maintenance planning, MROs. Training of men for medical equipments preventive and periodical maintenance procedures. Preparation of estimates, specifications, tender details etc. Importance of ISO 9000 Certificates

UNIT -V

Elements of Safety - Safety Publications and Standards Organizations - Orientation to Laboratory Safety - Types of risks in the hospitals - factors of environment - Safety showers and Eye Washes – Radiation hazards – radiation detection – safety measures – standards. Ergonomics - Flammables and Explosives – Formaldehydes - PEL Standards and Calculations - Material Safety - Organization of Safety in the hospitals.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. P.E. Stanley, Handbook of hospital safety, CRC Press
2. Arun Kumar, Hospital Management, Anmol Publications Pvt. Ltd.
3. S.K. Joshi Safety Management in Hospitals, JPB
4. Liam Donaldson, Walter Ricciardi, Susan Sheridan, Riccardo Tartaglia,Textbook of Patient Safety and Clinical Risk Management, Springer.

REFERENCE BOOKS:

1. William Charney, Handbook of Modern Hospital Safety, CRC press.
2. Webster J.C. and Albert M. Cook, “Clinical Engineering Principle and Practice”, Prentice

Hall Inc., Englewood Cliffs, New Jersey.

3. Goyal R.C., “Handbook of hospital personal management”, Prentice Hall of India, 1996.

DIGITAL ELECTRONICS

Course Code: 24BMP402	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO):

1. To study number systems and Boolean expressions.
2. To familiarize with concept of minimization techniques.
3. To analyze combinational and sequential circuits.
4. To learn concept of different logic families.
5. To apprentice different Programmable Logic Devices.

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:

1. Understand binary codes, binary arithmetic, minimization techniques and their relevance to digital logic design.
2. Design any Karnaugh map using SOP and POS Formula.
3. Design & analyze modular combinational circuits with MUX/DEMUX, Decoder, Encoder and sequential logic circuits.
4. Know the difference between logic families and applications.
5. Understand and implement various digital integrated circuits using different logic families and simple systems composed of PLDs.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CO/CLO	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

UNIT-I Number System & Boolean Algebra

Introduction to number systems- Types and Conversions, Binary Arithmetic, Signed Binary Numbers, Binary Codes - BCD, ASCII, Excess-3 codes, Gray codes, Code conversion, Boolean Algebra - De-Morgans Theorem, Reduction of Switching Equations Using Boolean Algebra.

UNIT-II Logic gates & Minimization Techniques

Introduction to logic gates- Design of two level gate network-Two level NAND-NAND and NOR-NOR networks, Universal property of NAND and NOR gates, Standard forms of Boolean equation-Minimization of SOP and POS Karnaugh maps - Advantages and Limitations- Quine-Mclusky Methods.

UNIT-III Combinational & Sequential Logic Design

Comparators, Multiplexers, Encoder, Decoder, Half and Full Adders, Subtractors, Parallel Adders, Adder with Look Ahead Carry, BCD Adder. Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Sequence Generator, Shift registers.

UNIT-IV Logic Families and Memory Circuits

Classification and Characteristics of Logic Families - Operation of TTL, RTL, DTL, HTL, ECL, MOS and CMOS. Comparison of Logic Families Memories-Random Access Memory - Static RAM, Dynamic RAM, Read Only Memory, Programmable memory- EPROM, EEPROM, Charge Coupled Device memory.

UNIT-V PLD's

Concept of Programmable logic devices like PAL, PLA, ROM, CPLD and FPGA. Logic implementation using Programmable Devices.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1.R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009

2. A.Anand Kumar, "Switching Theory & Logic Design", PHI.

3. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2 nd edition, 2006.

4. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989.

5. Morris Mano, "Digital Design: With an Introduction to the Verilog HDL", 5th Edition, Pearson Education, 2013.

6. Morris Mano, "Logic & Computer Fundamentals",4 th Edition, Pearson Education.

REFERENCE BOOKS:

1.Ronald J. Tocci, Digital System Principles and Applications , PHI, 6th Edition, 1997.

2. CharlesH.Roth, Fundamentals Logic Degisn ,Jaico Publishing,IV Edition,2002

3. Floyd, Digital Fundamentals, Universal Book stall, New Delhi, 1986.

THERAPEUTIC AND ASSIST DEVICES

Course Code: 24BMP403	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Explain the working principle of coronary care equipment
2. Overview the different components and working principle of sensory diagnosis and therapeutic equipment
3. Describe the use of different surgical equipment.
4. Interpretation of various types of assist devices.

COURSE LEARNING OUTCOME (CLO)

1. Description of coronary care equipment.
2. To clear view on therapeutic equipment used in hospital.
3. Computation of various equipment used for surgery in hospital.
4. Design and understand various types of assist devices.

MAPPING COURSE EDUCTIONAL OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS

UNIT -I INSTRUMENTS FOR CARDIOLOGY

Cardiac Pacemakers - Need for Cardiac Pacemaker - External Pacemakers - implantable Pacemakers - Recent Developments in Pacemaker system analyzer. Cardiac Defibrillators -Need for a Defibrillator - DC Defibrillator - Implantable Defibrillators - Pacer-cardio vector - defibrillator analysis.

UNIT – II INSTRUMENTS FOR SURGERY

Instruments for surgery - principle of surgical diathermy - surgical diathermy machine - safety aspects in Electro-Surgical diathermy Units. Physiotherapy and electrotherapy equipment - High frequency heat therapy - short wave Diathermy - Microwave diathermy - Ultrasonic therapy unit - Pain relief through Electrical Stimulation - Bladder Stimulators - Cerebellar Stimulators.

UNIT-III HAEMODIALYSIS AND VENTILATORS

Hemodialysis Machines - Function of the kidneys - Artificial Kidney - Dialyzers - Membranes of haemodialyzers - Haemodialysis machines - Portable Kidney machines. Lithotripters, Ventilators: Mechanics of Respiration - Artificial Respiration - Ventilators - Types of ventilators - Classification of Ventilators. Heart Lung Machine.

UNIT- IV ANESTHESIA AND VENTILATOR MACHINE

Need for Anesthesia and machine, Electronics in anesthesia machine, Mechanism of Respiration, Artificial Ventilation, Ventilators, Types of Ventilators, Classification, Modern and High frequency Ventilators, pressure- volume-flow diagrams.

UNIT -V ASSIST DEVICES FOR THE HEALTHCARE

Principles of external counter pulsation techniques, intra-aortic balloon pump, Defibrillator machine, Nerve and Muscle stimulators, Lithotriptors: The stone disease problem, Lithotriptor machine, modern systems, Extra Corporeal Shock Wave Therapy, Angiography

TEXT BOOKS:

1. R. S. Khandpur, Handbook of biomedical Instrumentation, Tata McGraw Hill Publication company Ltd, New Delhi, 1997.
2. Joseph J. Carr, John Michael Brown, Introduction to Biomedical Equipment Technology 4th edition, Pearson Education.2001.
3. John G. Webster, Biomedical Instrumentation, Wiley Publications. 2007.

REFERENCE BOOKS:

1. Albert-N. Cook & Webster. J. G. Therapeutical medical devices, Prentice hall INC, New Jersey, 1982.
2. RF Farr and PJ Allisy –Roberts, “Physics for Medical Imaging” Saunders, 1997.
3. P.Uma Devi, A. Nagarathnam, B S Satish Rao, “Introduction to Radiation Biology” B.I. Churchill Livingstone pvt ltd, 2000.
4. S.Webb, “The Physics of Medical Imaging”, Taylor and Francis, 1988.

BIOPHYSICAL SIGNALS AND SYSTEMS	
Course Code: 24BMP404	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES(CO)

1. Introductory knowledge concerning signals and systems with their applications.
2. To acquire knowledge for analyzing the continuous time, discrete time signals and systems.
3. Computation of response of a system for certain period of time.
4. Use of signals in various biomedical applications.

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:

1. Identify Classify the continuous time signals and systems and discrete-time signals and systems
2. Analyze the continuous time signals using Fourier series and Fourier transforms
3. Compute the convolution and correlation of discrete time systems.
4. Understand the concepts of z-transform and discrete Fourier transform
5. Categorization of discrete time IIR and FIR systems by using suitable structures and bio signal applications.

MAPPING MATRIX OF COURSE OBJECTIVES &COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			

CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS UNIT -I

Elementary Continuous time signals (CT signals), Step, Ramp, Pulse, Impulse, Exponential - Elementary Discrete time signals (DT signals)- Step, Ramp, Pulse, Impulse, Exponential, - representation of discrete-time signals-basic operation on signals-classification of signals- classification of systems, CT systems and DT systems, linear and nonlinear, time-variant and time in variant systems, static and dynamic systems, causal and non-causal systems.

UNIT- II

Representation of Fourier series, Continuous time periodic signals, properties of Fourier series, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum**.** Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function. Gibbs Phenomena.

UNIT -III

Natural response, Forced response, total response-Impulse response convolution integral, Impulse response of interconnected systems- causality stability- step response-correlation Review of Laplace transforms- Partial fraction expansion- Inverse Laplace transform-Concept of region of convergence (ROC) for Laplace transforms constraints on ROC for various classes of signals- Properties of Laplace transforms -relation between Laplace transform and Fourier transform Laplace transform of certain signals using waveform synthesis.

UNIT- IV

Sampling theorem – Graphical and analytical proof for Band Limited Signals, effect of under sampling, Aliasing. Fundamental difference between continuous and discrete time signals, discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time using complex exponential signal, discrete-time Fourier transform and its properties, Discrete Fourier Transform Concept of Z- Transform of a discrete sequence. Distinction between Laplace, Fourier and Z transforms. Region of convergence in Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-transforms.

UNIT- V

Physiological signals (ECG, EEG, EMG etc.), Generation of Physiological signal, Biomedical signal processing, stages: signal acquisition, Transformation and reduction of signals, computation of signal parameters that are significant, Interpretation and classification of the signal, Use of MATLAB signal processing Toolbox on various real bio-medical signals. Application Area like ECG measurement.

TEXT BOOKS:

1. P. Ramesh Babu & R. Ananda Natrajan, Signals and Systems, Third edition, SciTech Publications (India) Pvt. Ltd.,2007
2. Harish Parthasarathy, Signals and Systems, Second edition, Dreamtech Press Publications.
3. Alan V. Oppenheim, Alan S. Willsky, Signals and Systems, Second Edition, PHI publications.

REFERENCE BOOKS:

1. Robert A.Gael and Richard A Roberts, “Signals and Linear systems”, John Wiley and sons.
2. Roger E.Ziemer, “Signals and Systems Continuous and discrete”, McMillan.
3. Anand Kumar, Signals and systems, Second Edition, PHI publications.

BIOMEDICAL LASER INSTRUMENTATION	
Course Code: 24BMP501	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Gain the knowledge about the measuring instruments and the methods of measurement.
2. Familiarization of the students with various aspects of measuring electrical parameters from living body.
3. Introduce the students with the characteristics of medical instruments and related errors.
4. Hypothesize various recording systems.

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:

1. Describe and characterize the sources of biomedical signals and needs of using biomedical instruments & their limitations.
2. Summarization of pc based medical instrumentation & regulation of medical devices.
3. Enumerate the medical instruments as per their specifications, static & dynamic characteristics and understand data acquisition system.
4. Generalize and design various medical recording systems & their components.

MAPPING MATRIX BETWEEN COURSE OBJECTIVES AND COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS

UNIT I - Medical Instrumentation

Introduction and classification of biomedical instrumentation systems, components and design considerations of a biomedical instrumentation system, desirable characteristics in designing of biomedical instrumentation system, performance parameters of instruments. Frequency and amplitude ranges of Biosignals. ECG – Einthoven's triangle, 3 lead ECG system, Augmented and Precordial Lead system, 12 Lead ECG System, Origin and characteristics of EOG, ERG

UNIT II - Neuromuscular and Sensory systems

Description of Human Brain, Electroencephalogram (EEG), EEG – 10-20 electrode system, Montages and Channels and Electromyogram (EMG) measurement and recording, Block diagram description, evoked potentials, nerve conduction studies (NCS), biofeedback instrumentation, galvanic skin response (GSR) measurements.

UNIT III – Oximeter and Blood Flow meters

Oximeters & Blood Flow meters: Oximetry, Ear Oximeter, Pulse Oximeter, Skin Reflectance Oximeters, Intravascular Oximeter. Spirometry, Electromagnetic Blood flow meters - Sine and Square wave Electromagnetic Blood Flow meters, Ultrasonic Blood Flow meters, Blood Flow meter and Laser Doppler Blood Flow meter

UNIT IV –Patient monitoring system and Audiometers

Objective of patient monitoring system, Types: Cardiac Monitors, bedside monitors, central monitors, Ambulatory monitor. Computer assisted patient monitoring system, apnea detectors. Mechanism of Hearing, Measurement of sound, Basic Audiometer, Pure Tone Audiometer, Speech Audiometer, Audiometer System Bekesy, Evoked Response Audiometry System, Calibration of Audiometers.

UNIT V – ELECTRICAL SAFETY OF MEDICAL EQUIPMENT AND PATIENT

Patient safety, classification of medical devices and their safety standards, leakage current, micro, macro shock, different types of safety circuits for medical equipments, measures to reduce shock hazards. Special Techniques for measurement of Non-electrical biological parameters: Electrical Impedance Plethysmography (EIP), Photoplethysmograph (PPGs), respirometers.

TEXT BOOKS:

1. Principles of Medical Electronics and Biomedical Equipments: C Raja Rao and SK Guha,

(University Press India Limited)

2. Biomedical Instrumentation and Measurements: R Anandanatrajan (Prentice Hall of India)
3. Medical instrumentation, Webster John, John Wiley and sons, New York.2003.
4. Bio medical Instrumentation and Measurements, Cromwell Leslie, Fred J. Weibell, Erich

    A. Pfeiffer, PHI, 2nd edition, 2004.

REFRENCE BOOKS:

5. Principles of Biomedical Instrumentation and measurement: Richard Aston (Merill Publishers)
6. Handbook of Biomedical Instrumentation: RS Khandpur (Tata McgrawHill publishers)
7. Introduction to Biomedical Instrumentation: Mandeep Singh (Prentice Hall of India).
8. Principle of Applied Bio medical Instrumentation, Geddes L.A. and L.E.Baker, 3rd edition Wiley Interscience Publication, 1989.
9. Principles of Biomedical Instrumentation and Measurement, Richard Aston Merrill, Publishing Company, 1990.

TELEMEDICINE AND REMOTE PATIENT MONITORING	
Course Code: 24BMP502	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Elementary knowledge of physics and human physiology	

COURSE OBJECTIVES (CO)

1. This course will introduce the basic concepts of telemedicine and the technology used in healthcare system.
2. Describe the types of communication and network systems.
3. Explain the technologies used in data exchange and privacy of telemedicine.
4. Explain the development and transmission techniques used in telesurgery.
5. Describe the currents and futures perspective of telemedicine.

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:

1. Illustrate the current system of tele-health and mobile health.
2. Understand the different types of modes of communication and networks.
3. Describe the encryption and decryption of medical data.
4. Learn about telesurgery, robotic surgery and tools used in telesurgery.
5. Understand the future perspectives for telemedicine.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

COURSE CONTENTS

UNIT I

Background of Telemedicine: Introduction ,definitions of telemedicine, telehealth and telecare, Origins and development of telemedicine: from beginning to modern times, modern telemedicine and telecare, Drivers of telemedicine and telecare: technology drivers, non- technological drivers, the funding dilemma, Telemedicine in developed and underdeveloped countries ,benefits and limitations of telemedicine , Types of information and transmission in telemedicine: audio, video, still images, text and data.

UNIT II

Communication and Network Systems in Telemedicine, Types of communication and network: public switched telephone network, plain old telephone service, integrated services digital network, internet, asynchronous transfer mode, Wireless communications basics and its types ,Wireless sensor standards and homecare concerns, medical sensors for mobile communication devices, Development of disposable adhesive wearable human monitoring system, Implantable systems: implantable system architecture, Signal Processing in implantable neural recording microsystems, electronic health signal processing.

UNIT III

Technologies for Safeguarding Medical Data and Privacy, Data Exchanges: Network configuration, circuit and packet switching, Data security and standards: Encryption, cryptography, mechanisms of encryption, phases of encryption, Cryptography, safeguarding patient medical history, Anonymous data collection and processing, biometric security and identification

UNIT IV

Telehealth and Mobile Health, Medical robotics: surgical robots, rehabilitation robots Modern devices for tele-surgery: Main component and functionalities of a robotics tele-surgery System, design guidelines and methodology Microsurgery Systems: Robot-assisted microsurgery system, miniaturization, microsurgical tools, visualization methods and systems Image-guided microsurgery:

Image guidance component and workflow, image guidance by surgical domain

UNIT V

Implementation of Telemedicine and Future Trends in Technology Telecardiology: Tools and devices, Teleradiology and Tele-audiology, Telepathology system development and implementation Acute care telemedicine and monitoring for elderly care Virtual doctor systems for medical practices, wireless electrical impedance tomography, Synthetic biometrics in biomedical systems, bio-kinematics for mobility

TEXT BOOK

1. Olga Ferrer-Roca, M. Sosa Ludicissa, Handbook of Telemedicine, IOS press 2002.

REFERENCE BOOK:

1. A.C. Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002.

OPTICAL INSTRUMENTATION

Course Code: 24BMP503	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To understand the principles of light interference and its applications in various optical phenomena.
2. To analyze the concepts of light diffraction and the resolving power of optical instruments.
3. To explore the mechanisms of light polarization and its applications in technology.
4. To comprehend the fundamentals of nuclear reactions and the principles of particle accelerators.
5. To understand wave-particle duality and the fundamentals of crystallography and X-ray production.

COURSE LEARNING OUTCOMES (CLO)

1. Comprehend and appreciate the significance and role of interference in optical phenomena.
2. Demonstrate knowledge of Fresnel and Fraunhofer diffraction and their practical applications.
3. Describe the production and manipulation of polarized light, including its technological applications.
4. Explain the processes and implications of nuclear fission and fusion, and the functioning of particle accelerators.
5. Understand and apply the principles of quantum mechanics and crystallography to practical problems and experimental setups.

MAPPING MATRIX BETWEEN COURSE OBJECTIVES AND COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5

CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENT

UNIT I

Interference of light – Analytical treatment of interference – Coherent sources – Derivation of expression for fringe width in double slit experiment – White light fringes – Fringe shift with thin transparent plate – Interference on thin films – colour of thin films – Newton's rings – Air wedge – Planeness of surfaces.

UNIT II

Diffraction of light – Fresnel and Fraunohoffer diffraction – Zone plates – Plane diffraction grating – Measurement of Wave length – Dispersive power of grating – Resolving power – Raleigh's criterion – Resolving power of telescope and grating.

UNIT III

Polarization of light – Polarization by reflection – refraction – Brenster's law – Double refraction – Negative and Positive crystals – Nicol prism – Quarter and half wave plates – Production and detection of circularly and elliptically polarized lights – Rotatory polarization – Half shade polarimeter – Applications of polarized light.

UNIT IV

Nuclear fusion – Energy of fission – Chain reaction – Concept of critical size – Thermal power reactor – Breeder reactor – Atom bomb Fusion – Thermonuclear reaction – Fusion bomb – Particle accelerators – Cyclotron – Betatron. Module V Wave particle duality – The postulates of quantum mechanics – De Broghlie's concept of matter waves – properties of matter waves – Denisson &Germer's experiment – G.P. Thomsons experiment – Uncertainty principle – Crystal structure – Spare Lattice – Unit cell –

Crystal systems – Cubic – Body centered and fare centered cubes – Lattice Planes. Miller indices – sparing between lattice planes. Miller indices – sparing between lattice planes – Powder method for crystal study – production of x-rays. Continuum and characteristics X-ray – Bragg's law.

UNIT V

Light transport inside the tissue, optical properties of tissue. Laser Characteristics as applied to medicine and biology-Laser tissue Interaction-Chemical, Thermal, Electromechanical. Photo ablative processes.

TEXT BOOKS

1. J.B. Rajam – Modern Physics
2. Irving Kaplan – Atomic and Nuclear Physics
3. Sathyaprakash – Optics and Atomic Physics

REFRENCE BOOK

1. C. Kittel – Solid State Physics 5. R.P. Feynmenn – Lectures on Physics.
2. R. Splinter and B.A. Hooper, "An Introduction to Biomedical Optics", Taylor and Francis, 2007.

REHABILITATION ENGINEERING	
Course Code: 24BMP504	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES(CO)

1. Introductory knowledge of Rehabilitation engineering.
2. Use of Rehabilitation for the persons with disability.
3. To understand the working concepts of various rehabilitation equipment's for human movements.
4. To understand the wheeled mobility and sensory augmentation

COURSE LEARNING OUTCOMES(CLO)

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

1. To understand musculoskeletal, neuromuscular, sensory disorders.
2. To learn prosthetics and orthotics and their applications.
3. To learn how to implement these resources for well-being of humans.
4. To implement the knowledge for higher studies in developing innovative and effective rehabilitation and assistive technologies.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	

CO4				✓

COURSE CONTENTS

UNIT -IINTRODUCTION TO REHABILITATION

Introduction Concepts and principles of rehabilitation engineering, Ergonomics - Positioning anatomical site, simplicity and intuitive operation, adaptability and flexibility, mental and chronological age appropriateness. Knowledge of disability act 1995 for physically disabled, visually impaired, hearing impaired and others. Rehabilitation Team.

UNIT- II ORTHOTICS & ORTHOPROSTHETICS

Orthopedic prosthetics and orthotics in Rehabilitation Fundamentals, Applications: Computer Aided Engineering in customized component design. Intelligent prosthetic knee and hand. A self-aligning orthotic knee joint. FES System: Restoration of hand function; restoration of standing and walking. Hybrid Assistive systems (HAS) Active prostheses. Active Above knee Prosthesis. Myoelectric hand and arm prostheses. Orthotics - FO, AFO, TLSO, LSO

UNIT -III WHEELED MOBILITY

History and Categories of Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of wheel chair propulsion. Power Wheelchair Electrical System. Personal transportation. Tricycles.

UNIT- IV SENSORY AUGMENTATION AND SUBSTITUTION

Visual System: Visual augmentation. Tactual vision substitution. Auditory vision substitution: Auditory System: Auditory augmentation. Cochlear implantation. Visual auditory substitution. Tactual auditory substitution. Tactual system: Tactual augmentation. Tactual substitution. Alternative and Augmentative communication, User Interface: Outputs: Acceleration Techniques.

UNIT-V ADVANCED APPLICATIONS IN REHABILITATION

ENGINEERING

Interfaces in Compensation for visual perception. Improvement of orientation and mobility. Computer - assisted lip reading. Brain - computer interface. Electronic Travel Applications (ETA): Path Sounder, Laser Cane, Ultrasonic Torch, Sonic Guide, Light Probes, Nottingham Obstacle Sensor, Electro-cortical Prosthesis, Polarized Ultrasonic Travel Aid.

TEXT BOOKS

1. Handbook of Physical Medicine & Rehabilitation, W. B Saunders Publication, 2003.
2. Hanfredclynes, Biomedical Engineering System, McGraw Hill, 1999.
3. Joon Park, Biomaterials An Introduction, third edition, springer publications, 2007.

REFERENCE BOOKS

1. Bronzino, Biomedical Engineering, Hand Book IEEE Press Volume 1.
2. Robinson C. J, Rehabilitation Engineering, CRC Press. 1995.
3. Ballabio E. et al, Rehabilitation Technology, IOS Press. 1993.

BIOLOGICAL CONTROL SYSTEM	
Course Code: **24BMP505**	Continuous Evaluation:40 Marks
Credits: 3	End Semester Examination:60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. The objective of the course is to make the students familiar with basic of control system.
2. The course is providing the knowledge of this subject is required to have deeper grasp of the control environment/techniques.
3. The course is providing the understanding of closed loop systems.
4. Understanding of different types of control components and transfer functions.

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 explain

1. Interpretation of fundamentals of control system.
2. Understand the different type of control system and to analyse feedback characteristics of linear control system to reduce the disturbance.
3. Analyse the stability/behaviour of closed loop systems using various tools routh array, root locus and bode plot.
4. Learn about the transfer function and analyse different methods to find the transfer function.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		

CO3			✓	
CO4				✓

COURE CONTENTS UNIT-I

Basic elements of control system, open loop control system, closed loop control system, control system terminology, manually controlled closed loop systems, automatic controlled closed loop systems, basic elements of a servo mechanism, Examples of automatic control systems, linear systems, non-linear systems, control system examples.

UNIT-II

Control Components of control system, Control system representation Transfer function, block diagram, reduction of block diagram, problems on block diagram, Mason's formula signal flow graph

UNIT-III

Time Response Analysis Standard test signals, time response of first order system subjected to step and impulse input. Introduction to second order system (over damped, critically damped and under damped systems). Time domain specifications (Delay time, rise time, peak time, peak overshoot, settling time, steady state error).

UNIT-IV

Concept of stability, pole-zero configuration and stability, necessary and sufficient conditions for stability, Hurwitz stability criterion, Routh stability criterion and relative stability. Root locus concept, development of root loci for various systems, stability considerations

UNIT-V

Frequency Domain Analysis: Relationship between frequency response and time-response for 2nd order system, polar, Nyquist, Bode plots, stability, Gain-margin and Phase Margin, relative stability, frequency response specifications.

TEXT BOOKS

1. Control System Engineering: I.J. Nagrath & M. Gopal; New Age Publishers

2. Control Systems - Principles & Design: Madan Gopal; Tata Mc Graw Hill. Publishers

REFERENCE BOOKS

1. Automatic Control Systems: B.C. Kuo, PHI. Publishers.
2. Modern Control Engg: K. Ogata; PHI. Publishers.
3. Modern Control Engineering, R.C. Dorf & Bishop; Addison-Wesley Publishers

BIOSENSOR, DRUG DESIGN AND DEVELOPMENT	
Course Code: 24BMP506	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Biochemistry ar Pharmacology	

COURSE OBJECTIVES (COs)

1. To provide a comprehensive understanding of biosensors and their applications.
2. To introduce the principles and methods of drug design and discovery.
3. To familiarize students with the types, components, and functions of biosensors.
4. To understand the stages and techniques involved in drug discovery and development.
5. To learn about the regulatory aspects and ethical considerations in drug design.

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. Describe the fundamental concepts of biosensors, their types, and applications.
2. Understand and explain the process of drug discovery and the stages of drug development.
3. Characterize biosensors based on their physical and chemical properties.
4. Apply techniques for target identification, lead compound discovery, and optimization.
5. Analyze the regulatory and ethical aspects of drug design and development.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				

CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to Biosensors

Introduction and classification of biosensors, components of biosensors, principles of biosensor technology, performance parameters of biosensors, applications in healthcare, environmental monitoring, and food industry. Types of biosensors: electrochemical, optical, thermal, and piezoelectric biosensors.

Unit-2: Drug Discovery: Processes and Techniques

Introduction to drug discovery, stages of drug discovery and development, target identification and validation, lead compound identification, high-throughput screening, structure-based drug design, and computer-aided drug design. Structure-activity relationships (SAR) and quantitative structure-activity relationships (QSAR). Techniques for target identification and validation, combinatorial chemistry, molecular modeling, docking studies, and pharmacophore modeling. In vitro and in vivo models for drug testing.

Unit-3: Techniques in Drug Discovery and Development

Methods for target identification and validation, techniques for lead optimization, combinatorial chemistry, molecular modeling, docking studies, and pharmacophore modeling. In vitro and in vivo models for drug testing, biomarker discovery, and translational research.

Unit-4: Pharmacokinetics and Pharmacodynamics

Principles of pharmacokinetics and pharmacodynamics, absorption, distribution, metabolism, and excretion (ADME) of drugs, dose-response relationships, therapeutic index, and drug efficacy and toxicity. Methods for evaluating drug metabolism and pharmacokinetics.

Unit-5: Regulatory Aspects and Ethical Considerations

Regulatory framework for drug development, clinical trials, phases of clinical trials, Good Clinical Practice (GCP), ethical issues in drug design and development, intellectual property rights, and patenting in pharmaceuticals. Case studies on successful drug development and regulatory approval.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

5. **Biosensors: Theory and Applications**: Donald G. Buerk, Technomic Publishing Co., 1995.
6. **Drug Design: Methodology, Concepts, and Mode-of-Action**: E.J. Ariëns, Academic Press, 1971.
7. **Pharmacokinetics and Pharmacodynamics of Biotech Drugs: Principles and Case Studies in Drug Development**: Bernd Meibohm, Wiley-VCH, 2006.

REFERENCE BOOKS

1. **Biosensor Principles and Applications**: Loic J. Blum and Pierre R. Coulet, CRC Press, 1991.
2. **Introduction to Drug Design and Development**: P.N. Patil, New Age International Publishers, 2008.
3. **Clinical Trials: A Practical Guide to Design, Analysis, and Reporting**: Duolao Wang and Ameet Bakhai, Remedica, 2006.

4. **Handbook of Biosensors and Biochips**: Robert S. Marks, Christopher R. Lowe, David C. Cullen, Howard H. Weetall, and Isao Karube, Wiley, 2007.

5. **Good Clinical, Laboratory and Manufacturing Practices: Techniques for the QA Professional**: Phillip A. Carson and Nigel J. Dent, CRC Press, 2007.

NPTEL COURSES

1. **Drug Delivery: Principles and Engineering** - NPTEL Course on Drug Delivery

2. **Biomedical Nanotechnology** - NPTEL Course on Biomedical Nanotechnology

NEURAL NETWORKS AND FUZZY CONTROL	
Course Code: 24BMP601	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic knowledge of neural biology	

COURSE OBJECTIVES (COs)

1. To learn about the Neurophysiology and biological network
2. To extract the model of network and its process
3. To learn pattern recognition and feature extraction
4. To acquaint the students to state-of-the-art fuzzy-logic technology and fuzzy system design methodologies

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. Have to know about the process of neurophysiology
2. Have to gain knowledge about the neural networking process such as back propagation
3. Have a fundamental knowledge of pattern recognition and feature extraction
4. Comprehend the applications of fuzzy control systems

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4
CO1	✓			

CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS

UNIT I - INTRODUCTION

Artificial Neural Networks- Architectures, Definition and Fundamental Concepts, A Brief Overview - Engineering Approaches to Neural Computing- The Mappings View point, The Structure Viewpoint, Learning Approaches- Mathematical Foundations for ANN Study- Vector and Matrix Fundamentals- Geometry for State- Space Visualization- Optimization

UNIT II – PERCEPTRONS

Elementary ANN Building Blocks- Biological Neural Units, Artificial Unit Structures, Unit Net Activation to Output Characteristics- Artificial Unit Model Extensions- Single Unit Mappings and Perceptron - Introduction, Linear Separability, Techniques to Directly Obtain Linear Unit Parameters- Perceptrons and Adaline / Madaline Units and Networks- Multilayer Perceptrons- Gradient Descent Training using Sigmoidal Activation Functions.

UNIT III - PATTERN ASSOCIATORS & FEED-FORWARD NETWORKS

Introduction to Neural Mappings and Pattern Associator Applications- Neural Network based pattern associators- The Influence of Psychology on PA Design and Evaluation Linear Associative Mappings- Training and Examples- Hebbian or Correction based learning, Feed Forward Networks and Training- Multilayer Feedforward Network Structure- The Delta Rule- Architecture- Hidden Layer-MappingCapability.

UNIT IV – FUZZY SYTEMS AND FUZZY LOGIC CONTROL

Fuzzy Systems: Introduction, Classical sets – Fuzzy sets – Fuzzy relations – Fuzzification – Defuzzification – Fuzzy Rules-Fuzzy Implications and Approximate Reasoning. Fuzzy Logic Control: Membership function – Knowledge base – Decision-making logic – Optimisation of membership function using neural networks – Adaptive fuzzy system – Introduction to genetic algorithm.

UNIT V – APPLICATIONS OF FUZZY LOGIC CONTROL

Fuzzy Logic and Its Applications in Artificial Intelligence, Database and Information Systems,

Pattern Recognition. Fuzzy logic control – Inverted pendulum – Image processing – Home heating system – Blood pressure during anesthesia – Introduction to neuro fuzzy controller

TEXT BOOKS

1. Simon Haykin, "Neural Networks - A Comprehensive Foundation", Pearson Education Asia. 2002.

2. Mitchell Melanie, "An Introduction to Genetic Algorithm", Prentice Hall, 1998.

3. John Yen & Reza Langari, 'Fuzzy Logic – Intelligence Control & Information', Pearson Education, 2003.

4. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall, 1995.

REFERENCES

1. Yegnanarayana B. "Artificial Neural Networks", Prentice -Hall of India, 2004.

2. Robert J. Schalkoff, "Artificial Neural Networks", McGraw Hill International Ed, 1997.

3. James. A. Freeman and David. M. Skapura, "Neural Networks Algorithms, Applications and Programming Techniques", Pearson Education, 2002.

4. H.J. Zimmermann, 'Fuzzy Set Theory & its Applications', Allied Publication Ltd., 1996.

STATISTICAL COMPUTING WITH R	
Course Code: 24BMP602	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Statistics ar Programming	

COURSE OBJECTIVES (COs)

1. To introduce the basics of statistical computing and data analysis using R.
2. To teach students how to manipulate and visualize data using R.
3. To provide an understanding of statistical models and inference techniques.
4. To develop skills in writing R scripts for statistical analysis.
5. To familiarize students with advanced statistical techniques 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. Understand and apply basic R programming concepts for statistical computing.
2. Manipulate and visualize data using R.
3. Perform statistical analysis and interpret results.
4. Develop and implement statistical models using R.
5. Apply advanced statistical techniques to real-world data.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to R and Basic Data Handling

Overview of R and RStudio, installation and setup, basic R commands, data types and structures, reading and writing data, data manipulation using dplyr, handling missing data, and basic data summarization.

Unit-2: Data Visualization

Introduction to data visualization, plotting systems in R, base graphics, ggplot2, creating various types of plots (histograms, scatter plots, box plots, etc.), customizing plots, and saving plots.

Unit-3: Descriptive Statistics and Probability Distributions

Descriptive statistics (mean, median, mode, variance, standard deviation, etc.), probability theory, common probability distributions (normal, binomial, Poisson, etc.), and generating random numbers from distributions, Sampling distributions, central limit theorem.

Unit-4: Statistical Inference

Hypothesis testing (t-tests, chi-square tests, ANOVA), confidence intervals, p-values, and power of a test. Performing hypothesis tests in R. Simple linear regression, multiple linear regression, model diagnostics, assumptions of regression analysis, logistic regression, and interpreting regression outputs. Implementing regression models in R.

Unit-5: Advanced Statistical Techniques

Introduction to advanced topics: time series analysis, principal component analysis (PCA), clustering methods (k-means, hierarchical clustering), machine learning basics, and implementing these techniques in R.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. **R for Data Science**: Hadley Wickham and Garrett Grolemund, O'Reilly Media, 2016.
2. **The Art of R Programming: A Tour of Statistical Software Design**: Norman Matloff, No Starch Press, 2011.
3. **Introduction to Statistical Learning**: Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, Springer, 2013.

REFERENCE BOOKS

1. **Advanced R**: Hadley Wickham, Chapman and Hall/CRC, 2015.
2. **R Cookbook**: Paul Teetor, O'Reilly Media, 2011.
3. **Applied Statistics and Probability for Engineers**: Douglas C. Montgomery and George C. Runger, Wiley, 2010.
4. **Statistics with R Programming**: Manas A. Pathak, Springer, 2014.
5. **The R Book**: Michael J. Crawley, Wiley, 2012.

NPTEL COURSES

1. **Introduction to R Software** - NPTEL Course on Introduction to R
2. **Introduction to Data Analytics** - NPTEL Course on Data Analytics
3. **Statistical Inference** - NPTEL Course on Statistical Inference
4. **Data Science for Engineers** - NPTEL Course on Data Science

NANOTECHNOLOGY AND CLINICAL SCIENCE	
Course Code: 24BMP603	**Continuous Evaluation: 40 Marks**
Credits: 3	**End Semester Examination: 60 Marks**
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To understand fundamental knowledge of the Nanoscience and related fields
2. To make the students acquire an understanding the Nanoscience and Applications.
3. To gain knowledge in broad outline of Nanoscience and Nanotechnology.
4. To examine application of nanotechnology in Biomedical.

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:

1. Students will be able to learn about the background of Nanoscience;
2. Understand nanomaterial can be used for a diversity of analytical medicinal rationales;
3. Gain knowledge of nucleic acid-based Nanomaterial; Liposphere in drug target and delivery;
4. Application of nanotechnology in Biomedical and Life Sciences.

MAPPING MATRIX OF CO'S AND CLO'S:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS:

UNIT I- Introduction: Nanotechnology – definition and scope, nanobiotechnology- recent development and applications, Bioconjugation mediated drug delivery, carbon nanotubes – types and their biomedical applications, Immunotoxin, personalized nanomedicine.

UNIT II- Biopolymer: Biopolymer- classification and types, polymer nanofibers – electrospinning method and their biomedical Applications, biocompatible polymer and their application in tissue engineering, Biodegradable polymer derived from amino acid, Biocompatible nanomaterials, PLA and PLGA Based nanoparticulate delivery system.

UNIT III- Synthesis of Nanomaterials and nano formulations:

Top down and bottom-up approach forsynthesis of nanomaterials. Synthesis of nanomaterials using physical, chemical and biological methods. Characterization techniques for nanomaterials. Nano-bio-assemblies: Different types of inorganic materials used for the synthesis of hybrid nano-bio-Assemblies. Formulation of nanocrystals, nano emulsions, polymeric micelles

UNIT IV- Nucleic acid based Nanomaterials:

DNA based artificial nanostructures; Fabrication, properties and application-Nucleic acid engineered nanomaterials and their applications. Protein patterning for applications in biomaterials. DNA lipoplexes – Lipofection efficiency *In Vitro* and *In Vivo*, Polymer controlled delivery of therapeutic nucleic acid.

UNIT V- Nanotechnology in Biomedical and Life Sciences:

Diagnosis using nanomaterials, Nanoparticles for bioanalytical applications, Nanoparticles for MRI, X Ray, ultrasonography, gamma ray imaging, Approach to developing nanomedicines. Various kinds of nano-systems in use. Nanodrug administration nano-devices for drug delivery, Introductionto the potentials, applications and challenges of nanomedicine. Nanomedicine and tissue engineering, nano-bio-machines and nano-robots, engineering, nano-bio-machines and nano-robots.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS

1.Charles P. Poole Jr. and Franks. J. Qwens (2003) Introduction to Nanotechnology. John Wiley and Sons.

2.Ehud Gazit (2007) Plenty of Room for Biology at the Bottom: An Introduction to Bio nanotechnology. Imperial college Press

3.Bharat Bhushan (2007) Springer Handbook of Nanotechnology. Springer Verlag.

4.Challa S., S. R. Kumar, J. H. Carola (2006) Nanofabrication towards biomedical application: Techniques, tools, Application and impact. John Wiley and sons.

5.Robert A. Freitas Jr (2003) Nanomedicine, Vol. I: Basic Capabilities.

6.Understanding nanomaterials Malikat. S. Johl 2018

REFERENCE BOOKS

1.Neelina H. Malsch (2005) Biomedical Nanotechnology. Taylor and Francis. CRC press.

2.Patrick Boisseau, Marcel Lahmani (2009) Nanoscience: Nanobiotechnology and Nanobiology. Springer Publishers.

3.Ralph S. Greco, Fritz B. Prinz, R. Lane Smith (Editors) (2004) Nanoscale Technology in Biological Systems. CRC Press

4.Harry F. Tibbals (2010) Medical Nanotechnology and Nanomedicine. CRC Press.

5.Greco R. S., Prinz F. B., and Smith, R. L. (eds.), "Nanoscale Technology in Biological Systems", CRC Pres, ISBN: 0849319404, (2005).

6.Ratner, M. and Ratener, D, "Nanotechnology A Gentle Introduction to the Next BigIdea", Prentice Hall, ISBN: 0131014005, (2003).

NPTEL RESOURCES

1.Nanotechnology– NPTEL Course on Basics of Nanotechnology

2.Nanotechnology for Biomedical- NPTEL Course for Biomedical Nanotechnology

DEEP LEARNING & MACHINE LEARNING IN HEALTH CARE

Course Code: 24BMP604	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Machine Learning an Healthcare Systems	

COURSE OBJECTIVES (COs)

1. To introduce the fundamental concepts of machine learning and deep learning.
2. To apply machine learning techniques to healthcare data.
3. To understand the role of deep learning in medical image analysis.
4. To explore various healthcare applications of machine learning and deep learning.
5. To understand the ethical and regulatory aspects of AI in healthcare.

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 basics of machine learning and deep learning.
2. Apply machine learning algorithms to healthcare datasets.
3. Develop and evaluate deep learning models for medical image analysis.
4. Explore various real-world applications of AI in healthcare.
5. Analyze ethical and regulatory challenges in applying AI to healthcare.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			

CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to Machine Learning and Deep Learning

Overview of machine learning and deep learning, types of machine learning (supervised, unsupervised, reinforcement learning), introduction to neural networks, deep learning architectures (CNN, RNN, LSTM, GANs), and software tools (TensorFlow, Keras, PyTorch).

Unit-2: Machine Learning in Healthcare

Introduction to healthcare data (EMRs, genomic data, medical images), preprocessing and cleaning healthcare data, feature extraction and selection, supervised learning algorithms (regression, decision trees, SVM, k-NN), unsupervised learning (clustering, PCA), and evaluating model performance (confusion matrix, ROC curve, cross-validation).

Unit-3: Deep Learning for Medical Image Analysis

Introduction to medical image modalities (X-ray, CT, MRI, Ultrasound), convolutional neural networks (CNN) for image classification, segmentation, and detection, transfer learning, data augmentation techniques, evaluating deep learning models, and case studies on medical image analysis.

Unit-4: Applications of AI in Healthcare Unit Name

Predictive modeling for disease diagnosis and prognosis, personalized medicine, drug discovery and development, natural language processing (NLP) for clinical text analysis, wearable devices and health monitoring, and AI in telemedicine and remote patient monitoring.

Unit-5: Ethical and Regulatory Aspects

Ethical considerations in AI (bias, fairness, transparency), patient privacy and data security, regulatory frameworks (FDA, EMA) for AI-based medical devices, AI explainability and interpretability, and future trends and challenges in AI in healthcare.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. **Deep Learning**: Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, 2016.
2. **Machine Learning for Healthcare**: Kevin Murphy, MIT Press, 2020.
3. **Healthcare Data Analytics**: Chandan K. Reddy and Charu C. Aggarwal, CRC Press, 2015.

REFERENCE BOOKS

1. **Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow**: Aurélien Géron, O'Reilly Media, 2019.
2. **Deep Learning for Medical Image Analysis**: S. Kevin Zhou, Hayit Greenspan, and Dinggang Shen, Academic Press, 2017.
3. **Artificial Intelligence in Healthcare**: Adam Bohr and Kaveh Memarzadeh, Academic Press, 2020.
4. **Applied Predictive Modeling**: Max Kuhn and Kjell Johnson, Springer, 2013.
5. **Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes**: Arjun Panesar, Apress, 2019.

NPTEL COURSES

1. **Deep Learning** - NPTEL Course on Deep Learning
2. **Introduction to Machine Learning** - NPTEL Course on Machine Learning
3. **Artificial Intelligence: Knowledge Representation and Reasoning** - NPTEL Course on AI
4. **Biomedical Signal Processing** - NPTEL Course on Biomedical Signal Processing

THERAPEUTIC AND ASSIST DEVICES LAB	
Code: 24BM553	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Practical Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: NIL	

LAB OBJECTIVE (LO)

1. To provide hands on training on Measurement of physiological parameters
2. Study the function of different biomedical equipment
3. To introduce students with basic operation of diathermy
4. Gain knowledge about measurements of parameters related to respiratory system

LAB LEARNING OUTCOME (LLO)

1. Understand the measurement of physiological parameters
2. Describe the functional characteristics of therapeutic equipment
3. Understand & describe the basic operation of diathermy unit
4. Study about various parameters used for respiratory measurement

MAPPING LAB OBJECTIVES & LAB LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

LIST OF EXPERIMENTS

1. To study the Surgical Diathermy
2. Demonstration of Defibrillator (Demo)
3. To study the Haemodialysis
4. Demonstration of Ventilators

5. Demonstration of Anesthesia Machine
6. To study the Pacemaker (Demo).
7. Realization of pulmonary function analyzer using spirogram.
8. To study oximeters
9. To determine Bradycardia and Tachycardia using ECG Training Kit
10. To determine heart rate using ECG simulator Kit.

TEXT BOOKS:

1. Departmental Lab Manual
2. R. S. Khandpur, Handbook of biomedical Instrumentation, Tata McGraw Hill Publication company Ltd, New Delhi, 1997.
3. Joseph J. Carr, John Michael Brown, Introduction to Biomedical Equipment Technology 4th edition, Pearson Education.2001.

REFERENCE BOOKS:

1.Albert-N. Cook & Webster. J. G. Therapeutical medical devices, Prentice hall INC, New Jersey, 1982.

SIGNALS AND SYSTEM LAB

Course Code: 24BM554	**Continuous Evaluation: 60 Marks**
Credits: 1	**End Semester Examination: 40 Marks**
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (CO):

1. Introductory knowledge concerning signals and systems with their applications.
2. To acquire knowledge for analysing the continuous time, discrete time signals and systems.
3. Computation of response of a system for certain period of time.
4. Use of signals in various biomedical applications.

COURSE LEARNING OUTCOME (CLO):

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

1. Knowledge of Classify the continuous time signals and systems and discrete-time signals and systems
2. Analyse the continuous time signals using Fourier series and Fourier transforms
3. Compute the convolution and correlation of discrete time systems.
4. Understand the concepts of z-transform and discrete Fourier transform
5. Analyse the discrete time IIR and FIR systems by using suitable structures and bio signal applications.
6.

MAPPING LAB OBJECTIVES & LAB LEARNING OUTCOMES:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓	✓	

CO4					✓

LIST OF EXPERIMENTS

1. Study of Acquisition of signals
2. Introduction to MATLAB.
3. Basic tool box of MATLAB.
4. Generation of signals using MATLAB
5. Signal representation in MATLAB
6. Sampling of the signals
7. Addition, subtraction and multiplication of the signals
8. Design of low pass filter
9. Design of high pass filter
10. Signal Processing tool box

TEXT BOOKS:

1. Departmental Lab Manual
2. Raphael C. Gonzalez and Richard E. Woods, Digital Image Processing, 2nd Edition, 2001.
3. Anil K. Jain, Fundamentals of Digital Image Processing, 4th Edition, 1989.
4. S. Sridhar, Digital Image Processing, 2nd Edition.

REFERENCE BOOKS:

1. Robert A.Gael and Richard A Roberts, “Signals and Linear systems”, John Wiley and sons.
2. Roger E.Ziemer, “Signals and Systems Continuous and discrete”, McMillan.
3. A. Anand Kumar, Signals and systems, Second Edition, PHI publications.

MEDICAL IMAGE PROCESSING	
Course Code: 24BMP605	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. Introductory knowledge concerning medical image processing.
2. To emphasize on fundamental concepts of image acquisition and image processing.
3. To understand how to apply image processing techniques for various medical images.
4. Basics of Image Compression techniques for biomedical applications.

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:

1. Understand the image enhancement and image restoration techniques.
2. Describe the various image enhancement and image restoration techniques.
3. Apply various image segmentation methods and analysis in medical images.
4. Illustrate the basic concepts of wavelets and image compression techniques.
5. Explain the different types of reconstruction techniques applied to various medical Images

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CO/CLO	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	✓

COURSE CONTENTS

UNIT- I IMAGE FUNDAMENTALS

Structure of Human Eye - Image formation in eye. Fundamental steps on Image processing - components of image processing system. Basic relationship between pixels Image sensing and acquisition. Image formation model, Image sampling and quantization, aliasing, Zooming and shrinking of digital images. File Formats.

UNIT- II IMAGE ENHANCEMENT

Enhancement by point processing - Simple intensity transformation - Histogram processing - Image subtraction - Image averaging. Spatial filtering - Smoothing filters, sharpening filters. Enhancements in frequency domain - Low pass filtering - High pass filtering. 1D DFT, 2D DFT and their properties.

UNIT -III IMAGE RESTORATION

Model of Image degradation / restoration process. Restoration using spatial filtering - Mean Filter-Medium filter - Max and Min filter - Midpoint filter. Wiener filter. Noise reduction using Frequency domain filtering - band Reject Filter, Band pass filter - Notch filter. Inverse filtering, least mean square filter.

UNIT- IV IMAGE SEGMENTATION AND COLOR IMAGE

Detection of discontinuities, Edge and Line Detection, region-based segmentation. Color image processing - Color models, Pseudo color image processing, full color image processing. Morphological Image Processing: Preliminaries, dilation, erosion process.

UNIT- V IMAGE COMPRESSION

Data Redundancy, Image compression model - Source Encoder and Decoder, Channel encoder and decoder Information channel - Fundamental coding theorems - Noiseless coding - Noisy coding theorem

TEXT BOOKS:

1. William K. Pratt, Digital Image Processing, 4th Edition, 2007.

2. B. Chandra and Durtta Mujamdar, Digital Image Processing and Analysis, 2006.

REFERENCE BOOKS:

1. Raphael C. Gonzalez and Richard E. Woods, Digital Image Processing, 2nd Edition, 2001.

2. Anil K. Jain, Fundamentals of Digital Image Processing, 4th Edition, 1989.

3. S. Sridhar, Digital Image Processing, 2nd Edition.

DESIGNING CONCEPT, MAINTENANCE, AND TROUBLESHOOTING OF BIOINSTRUMENTATION	
Course Code: 24BMP606	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES(CO)

1. Introductory knowledge of bioinstrumentation.
2. To understand and learn the troubleshooting of instruments used for diagnosis and therapy
3. Learn how to maintain the overall working of equipment.
4. Address the management issues pertaining to medical instruments.

COURSE LEARNING OUTCOMES(CLO)

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

1. Identify major reasons for equipment failure.
2. Compare general testing and troubleshooting of equipment.
3. Discuss about the troubleshooting of medical equipment and safety standards.
4. Apply the tools in design, testing and developing medical equipment

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	

CO4				✓

COURSE CONTENTS

UNIT I – INTRODUCTION

Testing of electrical equipments: AC, DC power supply, Grounding, shielding, Guarding, insulation testing, insulation resistance measurement, Types of Circuit Breakers, Rating - Testing of circuit breakers – Tranformer testing- Earthing –Earth wires - Earthing of appliances – contactor, relay testing–CT and PT, Panel wiring- Megger-Testing equipments and instruments.

UNIT II – TESTING AND TROUBLESHOOTING Testing of electronic components: Troubleshooting of PCB boards, Calibration of analog and digital sensor probe, Display interface, DC Power supply design, testing, Safe electrical practice, Cables and standard, Fuse.

UNIT III – TESTING OF MEDICAL EQUIPMENT

Testing of surgical Equipment: Functions and operating procedure-Testing and maintenance of Heart lung machine, surgical lights, ventilator, patient monitor, anesthesia machine, dialyzer, surgical tools.

UNIT IV – TROUBLESHOOTING OF MEDICAL EQUIPMENT

Troubleshooting of equipments: X-ray machines, Troubleshooting of ECG recorders, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, and quality and safety standards.

UNIT V – MAINTENANCE MANAGEMENT

Life cycle management of medical equipment: Cost of the medical equipment, maintenance cost, replacement analysis, managing equipment service, decision making, extracting optimal benefit from medical equipment over its life cycle. Case study.

TEXT BOOKS

1. Shakti Chatterjee, Aubert Miller, "Biomedical Equipment Repair", Cengage Learning

Technology & Engineering, 2010.

2. David Herres, “Troubleshooting and Repairing Commercial Electrical Equipment”, McGraw Hill Professional edition, 2013.

REFERENCE BOOKS

1. Rao S, “Testing, Commissioning, Operation and Maintenance of Electrical Equipment”, Khanna Publishers, New Delhi, 2014.

2. Francis Hegarty, John Amoore, “Health care technology management – A systematic approach”, CRC Press, USA, 2017.

MATHEMATICAL MODELING AND SIMULATION WITH MATLAB	
Course Code: 24BMP702	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Mathematics ar Programming	

COURSE OBJECTIVES (COs)

1. To introduce the fundamental concepts of mathematical modeling and simulation.
2. To develop skills in formulating mathematical models for real-world problems.
3. To teach students how to use MATLAB for modeling and simulation.
4. To provide an understanding of various simulation techniques.
5. To apply mathematical models and simulations to engineering and scientific problems.

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 principles of mathematical modeling and simulation.
2. Formulate mathematical models for real-world problems.
3. Utilize MATLAB for developing and analyzing mathematical models.
4. Apply various simulation techniques to study the behavior of models.
5. Solve engineering and scientific problems using mathematical modeling and simulation.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			

CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to Mathematical Modeling and MATLAB Basics: Introduction to mathematical modeling: Types of models (deterministic, stochastic, continuous, discrete), steps in model development, validation, and verification of models, Applications of mathematical modeling in various fields, Introduction to MATLAB environment: Basic commands and functions, variables and data types, scripts and functions, control statements (if, for, while), and plotting and visualization in MATLAB.

Unit-2: Differential Equations and Dynamic Systems: Modeling with ordinary differential equations (ODEs): Initial value and boundary value problems, Numerical methods for solving ODEs: Euler's method, Runge-Kutta methods, Modeling dynamic systems and stability analysis.

Unit-3: Discrete Event Simulation and Optimization Techniques: Introduction to discrete event simulation: Monte Carlo simulation, random number generation, and statistical analysis of simulation results, Applications of discrete event simulation, Introduction to optimization: Linear and nonlinear programming, constrained and unconstrained optimization, Optimization techniques in MATLAB.

Unit-4: Parameter Estimation and Advanced Modeling Techniques: Parameter estimation methods: Least squares, maximum likelihood estimation, Case studies in optimization and parameter estimation, Advanced modeling techniques: Partial differential equations (PDEs) and their applications, finite element method (FEM), finite difference method (FDM).

Unit-5: System Identification and Advanced Topics in Simulation: System identification: Methods and applications, Advanced topics in simulation: Agent-based modeling, neural network modelling, Integration of simulation techniques for comprehensive modeling and problem-solving.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. "Mathematical Modeling and Simulation: Introduction for Scientists and Engineers" by Kai Velten, Wiley, 2009.
2. "MATLAB for Engineers" by Holly Moore, Pearson, 2017.
3. "Applied Numerical Methods with MATLAB for Engineers and Scientists" by Steven C. Chapra, McGraw-Hill Education, 2017.

REFERENCE BOOKS

1. "MATLAB: A Practical Introduction to Programming and Problem Solving" by Stormy Attaway, Butterworth-Heinemann, 2016.
2. "Introduction to the Numerical Solution of Differential Equations" by Douglas Faires, Academic Press, 1996.
3. "Simulation Modeling and Analysis" by Averill Law, McGraw-Hill Education, 2014.

NPTEL COURSES

1. Mathematical Modeling and Simulation
2. Introduction to MATLAB
3. Numerical Methods using MATLAB

MATHEMATICAL MODELING AND SIMULATION WITH MATLAB LAB	
Course Code: 24BMP752	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: "Mathematical Modeling and Simulation with MATLAB" lecture course	

COURSE OBJECTIVES (COs)

1. To provide hands-on experience with MATLAB for modeling and simulation.
2. To reinforce theoretical concepts through practical experiments.
3. To develop skills in writing and debugging MATLAB scripts and functions.
4. To apply MATLAB to solve real-world engineering and scientific problems.
5. To enable students to analyze and interpret simulation results.

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. Write and execute MATLAB scripts and functions for mathematical modeling.
2. Implement numerical methods for solving differential equations in MATLAB.
3. Conduct simulations to study the behavior of dynamic systems.
4. Apply optimization techniques using MATLAB.
5. Analyze and interpret the results of simulations and experiments.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			

CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

1. **Introduction to MATLAB:** Explore the basics of MATLAB environment, writing scripts, and plotting simple graphs.
2. **Data Types and Structures:** Work with various data types (arrays, matrices, cell arrays) and manipulate data**.**
3. **Control Statements and Loops:** Implement control statements and loops, and create custom functions.
4. **Plotting and Visualization:** Create, customize, and export various types of plots in MATLAB.
5. **Numerical Methods for Solving ODEs:** Implement Euler's method and use built-in functions to solve ODEs.
6. **Simulation of Dynamic Systems:** Model and simulate the behavior of dynamic systems using ODE solvers.
7. **Discrete Event Simulation:** Implement Monte Carlo simulation and analyze random processes.
8. **Optimization Techniques:** Apply basic optimization techniques and solve real-world problems using MATLAB.
9. **Parameter Estimation:** Use curve fitting and regression analysis for parameter estimation and validation.
10. **Advanced Modeling Techniques:** Model PDEs using finite difference method and simulate with MATLAB PDE toolbox.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. "MATLAB for Engineers" by Holly Moore, Pearson, 2017.
2. "Applied Numerical Methods with MATLAB for Engineers and Scientists" by Steven C. Chapra, McGraw-Hill Education, 2017.

REFERENCE BOOKS

1. "MATLAB: A Practical Introduction to Programming and Problem Solving" by Stormy Attaway, Butterworth-Heinemann, 2016.
2. "The MATLAB Handbook" by Kevin D. Donohue, Springer, 2018.

NPTEL COURSES

1. Mathematical Modeling and Simulation
2. Introduction to MATLAB
3. Numerical Methods using MATLAB
4. Optimization Techniques

BIOETHICS, BIOSAFETY AND IPR	
Course Code: 24BMP703	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Elementary knowledge of physics and human physiology	

COURSE OBJECTIVES(CO)

1. To recognize the students will be able to know about the legal and ethical principles in health care settings.
2. To gain knowledge about the medical standards that to be followed in hospitals.
3. Professional ethics to be followed by Biomedical Engineers.
4. Patient safety and regulatory aspects followed in hospitals
5. Intellectual Property Rights.

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:

1. Legal and professional guidelines for the health professions.
2. Social responsibility in healthcare systems.
3. Bioethics and engineer's role.
4. Medical device maintenance.
5. Understand safety aspects.

MAPPING MATRIX OF CO'S AND CLO'S:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			

CO3			✓		
CO4				✓	
CO5					✓

UNIT I INTRODUCTION TO MEDICAL ETHICS: Definition of Medical ethics, Scope of ethics in medicine, international code of ethics for occupational health professionals, Ethical Theories -- Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Role of ethics in Health care workplace – Autonomy, Non-Malfeasance, Beneficence, Veracity, Justice, OSHA, Decision Model for Healthcare Dilemmas Applications of Plus decision-making model.

UNIT II SOURCES OF MEDICAL LAW AND ETHICS: Nature and sources of medical ethics, Sources of medical law. Consent, Confidentiality and Clinical Negligence: Consent to Treatment, Confidentiality and Clinical Negligence.

UNIT III MEDICAL DEVICE SAFETY: Shared Responsibility for Medical device safety. WHO – International Health Regulations (IHR), Stages of regulatory control of medical devices, Ethics committee- its members and functions, Global Harmonization Task Force (GHTF). Quality systems requirement –ISO, Voluntary and mandatory standards, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device, International Standards and safety code

UNIT IV Biosafety :

Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment. General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc;

UNIT V - INTELLECTUAL PROPERTY RIGHTS: Intellectual property rights - patents and methods of application of patents - legal implications- objectives of the patent system - basic principles and general requirements of patent law-biotechnological inventions and patent law - patentable subjects.

TEXTBOOKS:

1. William Charney, "Handbook of Modern Hospital Safety'', CRC Press, 2nd Edition, 2009.
2. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, "Inspection of Medical Devices: For Regulatory Purposes", Springer Nature, 2018.
3. Domiel A Vallero , "Biomedical Ethics for Engineers", Elsevier Pub.1st Edition, 2007.
4. Singh.K, "Intellectual Property rights in Biotechnology", , BCIL, New Delhi.

REFERENCE BOOKS:

1. Eileen E.Morrison, "Ethics in Health Administration: A Practical Approach for Decision Makers'',Jonnes and Bartletts' Publication, 2nd Edition, 2011.
2. Robert M Veatch, "Basics of Bio Ethics'', Prentice- Hall, Inc., 2nd Edition, 2003.
3. Physical Environment Online: A Guide to The Joint Commission's Safety Standards is published by HCPro, Inc., 2010.

4. Joint Commission Accreditation Standards for Hospitals ,2nd Edition, 2003.

Advance Medical Imaging	
Course Code: 24BMP704	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Knowledge of medical imaging	

COURSE OBJECTIVES (COs)

1. To provide an in-depth understanding of various advanced imaging modalities used in medical diagnostics and their clinical applications.
2. To explore the principles, instrumentation, and advancements in digital radiography, thermography, optical imaging, and nuclear imaging.
3. To impart knowledge on radiation safety, protection strategies, and regulatory requirements in medical imaging.
4. To understand the biological effects of radiation and the principles of radiation protection.
5. To develop practical skills in operating imaging equipment, analyzing images, and applying safety protocols in clinical settings.

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. Demonstrate proficiency in the principles, techniques, and applications of angiography, fluoroscopy, mammography, and digital radiography.
2. Analyze and utilize thermography equipment and optical imaging techniques for clinical applications.
3. Evaluate the instrumentation, clinical applications, and characteristics of SPECT/PET and radiopharmaceuticals.
4. Apply radiation protection concepts, understand different types of radiation and their biological effects, and comply with regulatory standards.
5. Implement radiation protection strategies, understand occupational exposure limits, and assess factors affecting radiosensitivity.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

COs \ CLOs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓	✓			
CO2	✓	✓	✓		
CO3				✓	✓
CO4				✓	✓
CO5	✓	✓	✓	✓	✓

COURSE CONTENTS

Unit 1: Radiology and Digital Imaging: Angiography: Principles, techniques, and clinical applications, Fluoroscopy: Instrumentation, real-time imaging, and clinical uses, Mammography: Techniques, equipment, and breast cancer screening, Digital Radiography: Flat-panel detectors, image acquisition, and processing, C-ARM & Dental X-Ray: Portable imaging systems and applications in dentistry, Endovascular Robotics: Integration with imaging systems, applications in minimally invasive procedures, Principles of Radiation Dosimetry: Measurement, calculation, and management of radiation dose.

Unit 2: Thermography and Optical Imaging: Physics of Thermography: Infrared radiation, heat transfer, and thermographic imaging, Infrared Detectors and Sensors: Types, principles of operation, and applications in medical imaging, Thermography Equipment: Design, components, and clinical applications, Advantages of Optical Imaging: Non-invasiveness, resolution, and contrast, Optical Coherence Tomography (OCT): Principles, instrumentation, and clinical applications, Emission Tomography: Basics of radioactivity, types of detectors, and fundamental principles, Anger Scintillation Camera: Construction, working principles, and clinical use.

Unit 3: Nuclear Imaging and Radiopharmaceuticals: SPECT/PET Instrumentation: Design, functionality, and image reconstruction, Clinical Applications of SPECT/PET: Oncology, cardiology, neurology, and other fields, Radiopharmaceuticals Characteristics: Types, properties, and mechanisms of localization, Applications of Radiopharmaceuticals: Diagnostic and therapeutic uses, Gamma Camera: Construction, working principles, and performance characteristics, Development of Betatron, Cobalt-60 Machine, Gamma Knife, Medical Linear Accelerator Machine, Cyberknife

Unit 4: Radiation Safety and Regulatory Requirements: Radiation Protection: Concepts, need, and safety measures, Types of Radiation: Ionizing and non-ionizing radiation, sources, and biological effects, Stochastic and Non-Stochastic Effects: Differences, examples, and implications, Safety Limits and Risk Factors: Dose limits, risk assessment, and management, Regulatory Bodies: International Commission on Radiation Protection (ICRP) and Atomic Energy Regulatory Board (AERB), Responsibilities and Safety Standards: Organizational structure, regulations, and compliance

Unit 5: Biological Effects and Radiation Protection Strategies: Introduction to Radiation Protection: Goals, principles, and implementation, Limits for Radiation Exposure: ALARA principle, maximum permissible dose, special considerations for pregnancy and children, Occupational Exposure Limits: Standards for healthcare workers and the public, Biological Effects of Radiation: Direct and indirect actions, deterministic and stochastic effects, somatic and genetic impacts, Chronic Exposure and LD50: Long-term exposure effects and lethal dose 50%, Factors Affecting Radiosensitivity: Tissue type, age, and other variables affecting sensitivity to radiation

TEXTBOOKS

1. Introduction to Biomedical Imaging-Andrew G. Webb, Wiley-IEEE Press

2. Fundamentals of Medical Imaging -Paul Suetens, Cambridge University

REFERENCE BOOKS

1.The essential physics of medical imaging-. J. T. Bushberg, J.A. Seibert, E.M. Leidholdt Jr., J. Boone,LWW

2. Essentials of Ultrasound. – Michael R. Williamson, Saunders

ELECTRONICS DEVICES AND CIRCUITS	
Course Code: 24BMP301	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO):

1. To introduce basic semiconductor devices, their characteristics and application.
2. To learn to analyze the PN junction behavior at the circuit level and its role in the operation of diodes and active device
3. To apply concepts for the design of Regulators and Amplifiers.
4. To understand the operation of the various bias circuits of BJT, Analyze and design MOSFET bias circuits.
5. To Learn the operation and design of multistage amplifier for a given specification
6. To study oscillators and power amplifiers using transistor

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:

1. Understand the current voltage characteristics of semiconductor devices
2. Ability to analyze PN junctions in semiconductor devices under various conditions.
3. Design and analyze simple BJT circuits.
4. Design amplifier circuits and apply negative feedback principle to amplifier stages.
5. Understand the specifications of regulators and power supply circuits.
6. Capability to differentiate between different Oscillators and amplifiers for biomedical applications.

MAPPING MATRIX OF COURSE OBJECTIVES & COURSE LEARNING OUTCOMES:

CO/CLO	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6

CO1	✓	✓				
CO2		✓				
CO3			✓			
CO4				✓		
CO5					✓	
CO6						✓

COURSE CONTENTS

UNIT- I JUNCTION DIODE CHARACTERISTICS

Review of semi-conductor Physics – n and p –type semi-conductors, Mass Action Law, Continuity Equation, Hall Effect, Open-circuited p-n junction, The p-n junction as a rectifier (forward bias and reverse bias), The current components in p-n diode, Law of junction, Diode equation, Energy band diagram of p-n diode, Volt-ampere characteristics of p-n diode, Temperature dependence of V-I characteristic, Transition and Diffusion capacitances, Breakdown Mechanism in Semi-conductor Diodes, Zener diode characteristics.

UNIT- II JUNCTION TRANSISTOR, BIASING AND STABILIZATION

Transistor Current Components, Transistor as an amplifier, Configurations of Transistor (CE, CC, CB), Emitter Follower circuit, BIASING AND STABILISATION: DC Operating Point- DC equivalent model-Criteria for fixing operating point- Methods of Bias stabilization: fixed bias, emitter bias, voltage divider bias, Bias Stability, Stabilization against variation in Ico, VBE and Beta, Bias Compensation. BJT as Switch.

UNIT- III RECTIFIERS, FILTERS AND REGULATORS

Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit, Inductor filter, Capacitor filter, L- section filter, π- section filter, Multiple L- section and Multiple π- section filter and comparison of various filter circuits in terms of ripple factors, clippers, clampers, voltage multipliers. Simple circuit of a regulator using Zener diode. Series and Shunt voltage regulators- Analysis and design- Protection circuits for voltage regulators.

UNIT IV SPECIAL SEMICONDUCTOR DEVICES

Tunnel diode and characteristics- PIN diode- Varactor diode- Schottky diode- Gunn diode- Laser diode- photo conductive sensors- photo voltaic sensors- Light Emitting Diode (LED)- Avalanche Photo diode, Charge coupled device (CCD)- Silicon Control Rectifier (SCR)- two transistor equivalent, Applications of SCR, Unijunction Transistor (UJT).

UNIT-V AMPLIFIERS

Small signal low frequency transistor amplifier circuits: h-parameter representation of a transistor, Analysis of single stage transistor amplifier using h-parameters: voltage gain, current gain, Input impedance and Output impedance. –Temperature compensation using diode biasing, thermistor and sensitor compensation, Thermal run away-Thermal stability,

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. J. Millman, C. C. Halkias, and Satyabratha Jit, "Electronic Devices and Circuits" Tata McGraw Hill, 2nd Ed., 2007.
2. A.L Malvino & D. P. Leach, "Digital Principles and applications" TMH.
3. A.P. Malvino, "Electronics Principals" TMH 3rd Ed.
4. David A. Bell, "Electronic Devices and Circuits", Prentice Hall of India, 5th Edition, 2008.
5. Sedra and Smith, "Microelectronic circuits", Oxford University Press, 7th Edition, 2014.

REFERENCE BOOKS:

1. R.L. Boylestad and Louis Nashelsky, Electronic Devices and Circuits, Pearson/Prentice Hall, 9th Edition,2006.

2. P. Ramesh Babu, "Electronic Devices and Circuits" Scitech Publications Pvt, Ltd., 2008

3. Nagrath, ""Electronic Devices and Circuits" PHI Learning, 2006.

4. Muhammad H. Rashid, "Microelectronic Circuits: Analysis and Design", Cengage Learning, 6th Edition, 2013.

5. Thomas L. Floyd, "Electronic devices" Prentice Hall", 10th Edition, 2018.

6. Donald A Neamen, "Electronic Circuit Analysis and Design", Tata Mc Graw Hill, 4th Edition, 2009.

7. Robert L. Boylestad, "Electronic Devices and Circuit Theory", 11th Edition, 2015.

8. Robert B. Northrop, “Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation”, CRC Press, 2004.

ANALOG AND DIGITAL COMMUNICATION	
Course Code: 24BMP302	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO):

1. The objective of the course is to make the students familiar with detailed description of communication system.
2. To Familiarize with concepts of AM, FM and PM Techniques.
3. The course is providing the understanding of different Pulse Modulation Techniques.
4. Understanding of obtaining the modulated signal by using different techniques.
5. To provide in depth knowledge of transmitter and receiver design in digital communication and biomedical applications.

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:

1. Ability to formulate and interpret the presentation and processing of signals in Communication Systems.
2. Knowledge of concepts of transmission and reception of AM, FM, PM Transmission and Reception.
3. Capability to evaluate different Pulse Modulation Techniques.
4. Ability to access and evaluate different types of Modulators and Demodulators.
5. Ability to analyze the performance of baseband and passband digital communication systems along with biomedical applications.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES (CO & CLO)

CO/CLO	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		
CO4				✓	

CO5					✓

COURE CONTENTS

Unit-I

Introduction: Need for modulation, frequency translation and demodulation in communication systems - Basic scheme of a modern communication system.

Unit-II

Analog Modulation Techniques: Amplitude modulation: Derivation of expression for an amplitude modulated wave. Carrier and side band components. Modulation index. Spectrum and BW of AM Wave. Relative power distribution in carrier and side bands. Frequency modulation - Expression for frequency modulated wave and its frequency spectrum (without Proof and analysis of Bassel function) Modulation index, maximum frequency deviation and deviation ratio, BW of FM signals, Carson's rule. - Effect of noise on FM carrier. Noise triangle, Role of limiter, Need for pre-emphasis and de-emphasis, capture effect. - Comparison of FM and AM in communication system.

Unit-III

Analog Modulation and Pulse Modulation Techniques: Phase modulation - Derivation of expression for phase modulated wave, modulation index, comparison with frequency modulation. Statement of sampling theorem and elementary idea of sampling frequency for pulse modulation - Basic concepts of time division multiplexing (TDM) and frequency division multiplexing (FDM) - Pulse Amplitude Modulation (PAM), Pulse Position Modulation (PPM), Pulse Width Modulation (PWM).

Unit-IV

Introduction: Digital Communication

Introduction to Digital Communications, Nyquist Sampling Theorem, Information Sources, Random process, Quantization, Pulse Code Modulation, Multichannel and multicarrier systems: of DM.

Unit-V

Base Band Transmission

Line Coding and its properties, Various types of PCM waveforms, M-ary Pulse Modulation waveforms, Multiplexing PCM Signals, Delta Modulation, Idling Noise and Slope Overload, Adaptive Delta Modulation, Adaptive DPCM, Comparison of PCM and DM. Biomedical Applications of Communication Engineering.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Principles of Communication Engineering by Manoj Kumar, Satya Prakashan, New Delhi
2. Principles of Communication Engineering by Anokh Singh, S. Chand and Co., New Delhi
3. Principles of Communication Engineering by Roody , Coolen, Pearson Publisher
4. T. M. Cover and J. A. Thomas, "Elements of Information Theory," Wiley Student Edition, 1999, Reprint 2009.
5. U. Madhow, "Fundamentals of Digital Communication," Cambridge Univ. Press, 2008.

REFERENCE BOOKS:

1. Electronics Communication System by Kennedy, Tata McGraw Hill Education Pvt Ltd, New Delhi.
2. Principles of Communication Engineering by Taub, Tata McGraw Hill Education Pvt Ltd.
3. Electronics Communication by KS Jamwal, Dhanpat Rai and Co, New Delhi.
4. Radio Engineering by GK Mittal, Khanna Publishers, New Delhi.
5. B.P. Lathi and Z. Ding, "Modern Digital and Analog Communication Systems," 4th Ed., Oxford University Press, 2009.

HEALTHCARE DATA MANAGEMENT SYSTEMS	
Course Code: 24BMP411	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Database Management and Healthcare Systems	

COURSE OBJECTIVES (COs)

1. To provide an understanding of the fundamental concepts of healthcare data management.
2. To introduce various types of healthcare data and their sources.
3. To familiarize students with data standards and interoperability in healthcare.
4. To teach the principles and practices of healthcare data integration and management.
5. To explore data security, privacy, and ethical considerations in healthcare data management.

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 and significance of healthcare data management.
2. Identify and describe various types of healthcare data and their sources.
3. Understand and apply data standards and interoperability protocols in healthcare.
4. Design and manage healthcare databases and data integration systems.
5. Analyze the ethical, privacy, and security considerations in healthcare data management.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				

CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to Healthcare Data Management: Introduction to healthcare data management systems, importance of healthcare data management, types of healthcare data (structured, unstructured), sources of healthcare data (EHRs, medical imaging, wearable devices, patient-generated data), and data lifecycle.

Unit-2: Healthcare Data Standards and Interoperability: Overview of healthcare data standards (HL7, FHIR, DICOM, ICD, LOINC, SNOMED CT), importance of data standards, interoperability challenges, and solutions, data exchange protocols, and integration of healthcare systems.

Unit-3: Healthcare Databases and Data Integration: Database management systems (DBMS) in healthcare, relational and non-relational databases, data warehousing, data integration techniques, ETL (Extract, Transform, Load) processes, and health information exchange (HIE).

Unit-4: Data Security, Privacy, and Ethics: Data security principles, privacy laws and regulations (HIPAA, GDPR), data encryption techniques, access control mechanisms, ethical considerations in healthcare data management, patient consent, and data anonymization techniques.

Unit-5: Advanced Topics in Healthcare Data Management: Big data analytics in healthcare, cloud computing for healthcare data management, machine learning and AI applications, predictive analytics, real-time data processing, and case studies on healthcare data management systems.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. "Healthcare Data Management: An Introduction" by S. Mahdi, Springer, 2018.
2. "Health Informatics: An Interprofessional Approach" by Ramona Nelson and Nancy Staggers, Elsevier, 2016.
3. "Biomedical Informatics: Computer Applications in Health Care and Biomedicine" by Edward H. Shortliffe and James J. Cimino, Springer, 2014.

REFERENCE BOOKS

1. "Principles of Health Interoperability HL7 and SNOMED" by Tim Benson, Springer, 2012.
2. "Database Systems: Design, Implementation, & Management" by Carlos Coronel and Steven Morris, Cengage Learning, 2016.
3. "Health Information Exchange: Navigating and Managing a Network of Health Information Systems" by Brian Dixon, Academic Press, 2016.

NPTEL COURSES

1. Healthcare Data Management
2. Health Informatics
3. Data Mining
4. Big Data Computing

INTRODUCTION TO MEDICAL INFORMATICS	
Course Code: 24BMP412	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (COs)

1. To introduce the basic concepts in Biomedical Informatics and its applications in electronic medical record system and medical standards.
2. To acquaint the students to clinical decision support systems
3. To get acquainted with the currents and futures perspective of Medicalinformatics
4. Illustrate the current system of tele-health and mobile health

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. Familiarize with the fundamental concepts in biomedical informatics
2. Comprehend the applications of an electronic medical record systems
3. Apply the various aspects of health informatics
4. Familiar with advancement in telemedicine technologies

MAPPING COURSE OBJECTIVES (COS) AND COURSE LEARNING OUTCOMES (CLOs)

COs \ CLOs	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	

CO4				✓

COURSE CONTENTS

UNIT I - INTRODUCTION (9 hours)

The Science and the Pragmatics - Biomedical Data - Their Acquisition, Storage, and Use – Computer Architectures for Health Care and Biomedicine - Overview of hospital information system – Patient history taking mechanisms - Patient data processing - Database Management - Communication of medical data across different hospital units - Networking and Integration of patient data.

UNIT II - KNOWLEDGE – BASE AND EXPERT SYSTEMS (8 hours)

Artificial intelligence- expert systems- materials and methods- computer based patient Records- computer assisted medical education.

UNIT III – ELECTRONIC HEALTH RECORD AND HOSPITAL MANAGEMENT (11 hours)

Introduction- Hospital management and information system: functional area pre- requisites- integrated hospital information systems- health information system- and disaster management plan, computer assisted patient education.

UNIT IV - COMPUTER ASSISTED SURGICAL TECHNIQUES (10 hours)

Three-dimensional imaging: limitations of endoscopy and imaging- benefits of virtual endoscopy- materials and methods- limitations- applications- merits and demerits- surgical simulation- virtual environment

UNIT V-TELECOMMUNICATIONS BASED SYSTEMS (9 hours)

Tele-medicine- needs- materials and methods- Internet tele-medicine controversial issues- reliability- cost- analysis- applications- tele-surgery- the Internet

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS:

1. Mohan Bansal, "*Medical Informatics- a primer*", Tata McGraw-Hill, 2003.
2. De Dombal. F. T., "*Medical Informatics: The Essentials", *Butterworth-Heinemann, 1996.

REFERENCE BOOKS:

1. Edward H. Shortliffe and James J. Cimino, "*Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Health Informatics*)", 4th edition Springer, 2014
2. Hsinnchun Chen, "*Medical Informatics: Knowledge Management And Data Mining in Biomedicine"*, Springer, 2005.

ELEMENTS OF BIOTECHNOLOGY	
Course Code: 24BMP413	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (COs)

1. To understand basics of biotechnology.
2. To employ biotechnology principles in synthetic biology.
3. To define biotechnology and list some basic applications.
4. To apprehend and explain the biomedical applications of biotechnology.

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. To recognize the structural and functional principles of biotechnology.
2. To explain process for particular techniques in development of biotechnology product
3. To apply biotechnology knowledge in production systems.
4. Illustrate biotechnology to living systems with applications across a wide domain of biological sciences.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: INTRODUCTION: Overview and scope of biotechnology, Integration of biology, medicine and engineering, across different levels of the biological hierarchy and basic knowledge with applications; Living systems and biomolecules, engineering tools in simulation studies, bioinformatics and nanotechnology, bioprocess and bio-separation engineering.

Unit-2: APPLICATION OF BIOTECHNOLOGY: Bioactive compounds, Single cell protein, Synthetic biology Bioethanol, Biodiesel, Bioreactors, Membrane based bioseparations, Biomolecular electronics, Biosensors, Tissue engineering and devices, Biocement.

Unit-3: BIOTECHNOLOGY PRODUCT AND DESIGN:

Bioactive compounds, Single cell protein, Synthetic biology Bioethanol, Biodiesel, Bioreactors, Membrane based bioseparations, Biomolecular electronics, Biosensors, Tissue engineering and devices, Biocement.

Unit-4: BIOTECHNOLOGY IN ANIMAL PRODUCTION

Manipulation of Growth hormone -somatotropic hormone-Thyroid hormone; Probiotics as growth promoters - Ideal characteristics of probiotics, Mode of action-uses of probiotics- Manipulation of lactation – Lactogenesis- galactopoiesis - Manipulation of wool growth- Manipulation of rumen microbial digestive system.

Unit-5: PLANTS AS PRODUCTION SYSTEMS

Plant tissue culture-plasticity and totipotency, culture environment, growth regulators, media regulators, culture types, plant regeneration - Hairy root cultures - production of secondary metabolites-carbohydrate and lipid production- molecular pharming of proteins - emerging applications for producing fine chemicals, drugs, and alternative fuels.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. Smith J. E., Biotechnology, 3rd Edition, Cambridge University Press (2006)

2. Dhami, P.S., Srivastava, H.N. and Chopra, G., A Textbook of Biology, Pradeep Publications (2008).

REFERENCE BOOKS

1.Saltzman WM. Biomedical Engineering Bridging Medicine and Technology 2009 (ISBN-13: 9780521840996)

2.Starr, C., Evers C. A., Starr L. Concepts of Biology, First Edition, Cengage Learning India Pvt. Ltd. (2010)

MICROBIOLOGY	
Course Code: 24BMP414	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination:60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES

1. To introduce the fundamentals of microbiology and to highlight the roles and characteristics of microorganisms.
2. To study the growth of microorganisms and impact of environment on their growth in different media, their metabolic pathways.
3. To evaluate role of microbes in causing different diseases and public health.
4. To insight into the physical and chemical control of microorganisms and applications of microbiology.

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 categories of microorganisms and analyse their classification and diversity.
2. Identify and demonstrate structural, physiological, genetic similarities and differences of major categories of microorganisms.
3. Understand, how they cause different diseases and its control.
4. Demonstrate how to control microbial growth and their applications.

MAPPING MATRIX OF CO & CLO:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	✓

CO4				✓

COURSE CONTENTS

UNIT -I INTRODUCTION TO MICROBIOLOGY

Basic of microbial existence: History of Microbiology, classification, and nomenclature of microorganisms Overview of Bacteria, Archea, fungi, Algae, Viruses & Protozoa. Microscopy: Microscopic examination of microorganisms-morphology and fine structure of bacteria.

UNIT -II MICROBIAL NUTRITION, GROWTH AND METABOLISM

Nutritional requirements of bacteria: Culture media, Sterilization & Pure culture techniques. Growth, Growth curve and Different methods to quantitate bacterial growth. Metabolic diversity among microorganisms: Photo trophy, Chemolithotrophy, N2 fixation, Fermentation, Mycorrhiza.

UNIT -III MICROBIAL PHYSIOLOGY AND GENETICS

Fungi- Importance, characteristics, morphology, reproduction, physiology. Viruses: Structure, Classification, reproduction of bacterial, animal and plant viruses. Bacteriophages- General characteristics, Morphology and structure & Classification. Virioids and prions.

UNIT -IVMICROBIAL INFECTIONS, TRANSMISSION, AND THEIR MODE OF ACTION

Sources of infection: Portals of entry and exit of microbes. Infectious diseases caused by Bacteria: Leprocy, Tuberculosis & Cholera; By Viruses: Influenza, AIDS; By Protozoans: Malaria; By Fungi: Dermatomycosis. Antimicrobial agents/Antibiotics: Penicillin and Cephalosporins. Broad spectrum antibiotics: Antibiotics from Natural Sources. Antibacterial, Antifungal and Antiviral agents- Mode of action.

UNIT- V APPLIED MICROBIOLOGY

Microbial applications in Agricultural: Biofertilizers, Industrial: Dairy Product-Cheese & fermented milks, Fermented beverages- Beer & Wine, pharmaceutical: Antibiotics and environmental application: Biodegradation, Bioremediation &waste water treatment. Physical, chemical and biological control of microorganisms. Host-microbe interactions such as plant microbe interaction & animal-microbe interaction

TEXT BOOKS:

1. Michael J. Pelczar, S. Chan, and Noel R. Krieg "*Microbiology*", McGraw Hill, 7thEdition, 2011.
2. Michael T. Madigan, John M. Martinko, Paul V. Dunlap, and David P. Clark "*Brock Biology of microorganisms*", Prentice Hall, 12thEdition, 2008.
3. Joklik et al, "*Zinsser Microbiology*"- Appleton & Lange, 20th edition, 1997.
4. Stanier Y. Roger, Adelberg A. Edward, and Ingraham John "*General Microbiology*", Prentice Hall, 5thEdition, 1986.

REFERENCE BOOKS:

1. Geo Brooks, Karen C. Carroll, Janet Butel, and Stephen Morse "*Medical Microbiology*", McGraw- Hill Medical, 26thEdition, 2012.
2. Lansing M. Prescott, Donald A. Klein, and John P. Harley, "*Microbiology*", McGraw Hill, 11th Edition, 2011.

BIOINFORMATICS	
Course Code: 24BMP511	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Introductory knowledge concerning Biological Databases.
2. To understand Computational approaches to analyse the genomes and proteomes
3. Knowledge of molecular evolution and concept of Phylogeny.
4. Basic understanding of structural bioinformatics and molecular modeling.

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:

1. Develop an understanding of basic theory of these computational tools.
2. Gain working knowledge of these computational tools and methods
3. Appreciate their relevance for investigating specific contemporary biological questions;
4. Understanding the applications in various applied areas of biology.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS

UNIT I – BASICS OF HANDLING GENOMIC DATA

The Central Dogma; Human Genome Project: Introduction, Objectives, Outcomes and their applications and the need for databases and annotation, Definition of Bioinformatics, Applications, Limitations, Biological Databases- Primary, Secondary and Specialized databases, file formats; annotated sequence databases; Retrieval of biological data

UNIT II – SEQUENCE BASED ALGORITHMS AND SEARCHES

Similarity and identity among biological sequences; Amino acid substitution matrices: PAM and BLOSUM; Sequence similarity searches: local and global alignment algorithms, multiple sequence alignment, Database searching algorithm: BLAST.

UNIT III – PHYLOGENETIC ANALYSIS

Cladogram and Phylogram, Distance and Character Based Methods, Computer tools for phylogenetic analysis, Construction and Visualization of Phylogenetic analysis, Applications of Phylogenetic Analysis.

UNIT IV – STRUCTURAL BIOINFORMATICS

Relationship of protein three -dimensional structure to protein function; protein families and pattern databases; Classification of proteins of known three-dimensional structure: CATH & SCOP; Concept of molecular modelling: homology modelling, Fold Recognition, Ab Initio Protein Structural Prediction, CASP

UNIT V – BIOINFORMATICS IN DRUG DESIGN

Process of drug discovery -drug design and virtual screening -structure and ligand-based ligand design

-docking -scoring -small molecular libraries -lead optimization –pharmacophore.

TEXT BOOKS:

1. Pevzner, P.A., "Computational Molecular Biology", Prentice Hall, 2004.
2. Orengo C. A, Jones D.T., Thornton J. M., "Bioinformatics: Genes, Proteins and Computers", Roultledge Publisher, 2003.
3. Pevsner, J. Bioinformatics and Functional Genomics; John Wiley and Sons, 2003.
4. Teresa Attwood, "Introduction to Bioinformatics Paperback", Pearson Education, 2007.

REFERENCE BOOKS:

1. David W. Mount, "Bioinformatics", Cold Spring Harbor Press, 2004.
2. Baxevanis A. D., Ouellette B. F. "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", John Wiley and Sons, 2004.
3. Arthur M. Lesk, "Introduction to Bioinformatics-Fourth Ed.", Oxford University Press, 2018.

TELEMEDICINE AND REMOTE PATIENT MONITORING	
Course Code: 24BMP502	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Elementary knowledge of physics and human physiology	

COURSE OBJECTIVES (CO)

This course will introduce the basic concepts of telemedicine and the technology used in healthcare system.

1. Describe the types of communication and network systems.
2. Explain the technologies used in data exchange and privacy of telemedicine.
3. Explain the development and transmission techniques used in telesurgery.
4. Describe the currents and futures perspective of telemedicine.

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:

1. Illustrate the current system of tele-health and mobile health.
2. Understand the different types of modes of communication and networks.
3. Describe the encryption and decryption of medical data.
4. Learn about telesurgery, robotic surgery and tools used in telesurgery.
5. Understand the future perspectives for telemedicine.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

COURSE CONTENTS

UNIT 1: Background of Telemedicine:

Introduction ,definitions of telemedicine, telehealth and telecare, Origins and development of telemedicine: from beginning to modern times, modern telemedicine and telecare, Drivers of telemedicine and telecare: technology drivers, non- technological drivers, the funding dilemma, Telemedicine in developed and underdeveloped countries ,benefits and limitations of telemedicine , Types of information and transmission in telemedicine: audio, video, still images, text and data.

UNIT 2: Communication and Network Systems in Telemedicine:

Communication and Network Systems in Telemedicine, Types of communication and network: public switched telephone network, plain old telephone service, integrated services digital network, internet, asynchronous transfer mode, Wireless communications basics and its types ,Wireless sensor standards and homecare concerns, medical sensors for mobile communication devices, Development of disposable adhesive wearable human monitoring system, Implantable systems: implantable system architecture, Signal Processing in implantable neural recording microsystems, electronic health signal processing.

UNIT 3: Technologies for Safeguarding Medical Data:

Technologies for Safeguarding Medical Data and Privacy, Data Exchanges: Network configuration, circuit and packet switching, Data security and standards: Encryption, cryptography, mechanisms of encryption, phases of encryption, Cryptography, safeguarding patient medical history, Anonymous data collection and processing, biometric security and identification

UNIT 4: Telehealth and Mobile Health:

Telehealth and Mobile Health, Medical robotics: surgical robots, rehabilitation robots Modern devices for tele-surgery: Main component and functionalities of a robotics tele-surgery System, design guidelines and methodology Microsurgery Systems: Robot-assisted microsurgery system, miniaturization, microsurgical tools, visualization methods and systems Image-guided microsurgery: Image guidance component and workflow, image guidance by surgical domain

UNIT 5: Implementation of Telemedicine:

Implementation of Telemedicine and Future Trends in Technology Telecardiology: Tools and devices, Teleradiology and Tele-audiology, Telepathology system development and implementation Acute care telemedicine and monitoring for elderly care Virtual doctor systems for medical practices, wireless electrical impedance tomography, Synthetic biometrics in biomedical systems, bio-kinematics for mobility

TEXT BOOK

1. Olga Ferrer-Roca, M. Sosa Ludicissa, Handbook of Telemedicine, IOS press 2002.

REFERENCE BOOK:

1. A.C. Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002.

IMMUNOLOGY	
Course Code:24BMP513	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. Aimed at introducing the science of immunology and a detailed study of various types of immune systems their classification, structure, and mechanism of immune activation.
2. Fundamental concepts of immunity and the contribution of organs and cells in the development of immune response
3. Genetic control of Antibody production, cellular immunology
4. The role of the immune molecules in infectious diseases, autoimmunity, and cancer will be discussed

COURSE LEARNING OUTCOME (CLO)

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

1. The immune system, their structure and classification.
2. The fundamental concepts of immunity and the contribution of organs and cells in the development of immune response.
3. The role of genetics in generation of antibody diversity
4. Gain insight into the various aspects of immunogenetics, molecular immunology, clinical immunology & immune response to infectious diseases, auto immunity

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS

UNIT I OVERVIEW OF THE IMMUNE SYSTEM

Introduction: overview of the immune system-Lymphatic system, lymphoid organs, Cells of the immune system and their functions-Immune system. Innate and Acquired immunity: Cells and processes of Innate immunity—Cells and organs of the Acquired immunity- Anatomical and Physiological barriers; Innate Immune response and their recognition structures; Pathogen elimination. Immunogens and Antigens: Requirements for immunogenicity; major classes of antigens; antigen recognition by B and T lymphocytes

UNIT II ANTIBODY STRUCTURE AND FUNCTIONS, B CELL FUNCTION

Immunoglobulins: Structure and function-- Monoclonal antibodies. B Cell generation and differentiation: BCR--Antibody diversity: Genetic basis—T dependent activation of B cells-B-lymphocyte signal transduction. Cytokines and Complement system.

UNIT III MAJOR HISTOCOMPATIBILITY COMPLEX AND ANTIGEN PRESENTATION

Antigen- antibody interaction: Major Histocompatibility complex – types – structure and function; MHC restriction; Antigen Presenting Pathways

UNIT IV MATURATION, ACTIVATION & DIFFERENTIATION OF T AND B LYMPHOCYTES

T cell activation, maturation and differentiation: T-cell receptors--T-cell maturation, activation and differentiation-Cell mediated effector responses-Function of CD8+T cells and CD4+ cells. Effector Functions

UNIT V IMMUNE SYSTEM IN HEALTH & DISEASE

Hypersensitive reactions--Immune responses to infectious diseases—Tumour Immunology-Vaccines-Autoimmunity, Synthetic biology.

TEXT BOOKS

1. Richard Coico, Geoffrey Sunshine, "*Immunology: A short course*" 6th Edition. Wiley-Blackwell, 2009.

2. Kenneth Murphy, "*Janeway's Immunobiology*," 8th Edition, Garland, 2011

REFERENCE BOOKS

1. Sudha Gangal and Shubhangi Sontakke, "*Textbook of Basic and Clinical Immunology*", Orient Blackswan, 2013.

2. Thomas J. Kindt, Barbara A. Osborne , Richard A. Goldsby , " *Kuby Immunology*", WH Freeman, Sixth Edition, 2006.

OMICS FOR BME	
Course Code: 24BMP504	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: NIL	

Course Objectives (CO)

1. To have introductory knowledge concerning Meta-omics (genomics, transcriptomics proteomics & metabolomics and their applications.
2. To emphasize on structure and organization of genomes, Computational approaches to analyse the genomes,
3. To analyse gene expression by Microarray, functional genomics,
4. Basics of Transcriptomics & Proteomics and application.

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:

1. Knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics.
2. Information of the structure and functions of the genomes together with the computational approaches to analyse the genomes & proteome.
3. Understanding of the gene expression and functional genomics.
4. Understanding the applications in various applied areas of biology.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES (CO & CLO)

CO/CLO	CLO1	CLO2	CLO3	CLO4
CO1	✓			✓
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENT

UNIT I - GENOMES AND GENOMICS

Prokaryotic and eukaryotic genomes- structure- organization-Genomics: Genome Sequencing-Fragment Assembly- Genome Assembly- Human Genome Project- Aims- goals and achievements., Next Gen Sequencing (NGS)

UNIT II - GENE EXPRESSION PROFILING

Aligning Whole Genome Alignment (WGA) - prediction of coding regions – gene structure - conserved motifs, methods of gene discovery - Prediction of gene function - methods - annotation, Coding and non coding genes and RNA, Gene expression - regulatory mechanism, Expression profiling - Northern, RT-PCR, DD-RT-PCR, EST library - cDNA library, cDNA AFLP – SAGE Mechanical methods of delivery- Example: Duchenne myotrophy- Liposomal methods of delivery- Cystic fibrosis

UNIT III - TRANSCRIPTOMICS AND MICROARRAY

Gene regulatory network and the models- DNA micro array and the analysis of data using clustering methods, Transcription factor binding sites, RNA-Seq, Microarrays, Regulatory RNAs: small or large. Computational prediction of miRNA target genes

UNIT IV- INTRODUCTION AND SCOPE OF PROTEOMICS

Basic concepts: Protein separation techniques: ion-exchange, size exclusion and affinity chromatography techniques, Polyacrylamide gel electrophoresis; Isoelectric focusing (IEF); Two dimensional PAGE for proteome analysis; Image analysis of 2D gels; Introduction to mass spectrometry; Strategies for protein identification; Protein sequencing; Protein modifications and proteomics; Clinical and biomedical application of proteomics; Protein chips

UNIT V METABOLOMICS

Fundamental concept, Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors

TEXT BOOKS

1. T.A. Brown, *"Genome*", John Wiley & sons, 2006.

2. David W. Mount, "*Bioinformatics: Sequence and Genome Analysis*", Cold Spring Harbor Laboratory Press, I edition, 2001.

3. Stekel Dov*, "Microarray Bioinformatics*", Cambridge University Press, 2003.

REFERENCES

1. Issac S Kohane, *"Microarrays for an integrative genomics"*, The MIT Press, 2002.

2. Barh D, Azevedo V, *Omics Technologies and Bio-engineering: Towards Improving Quality of Life*, Academic Press, 2017.

3. Benjamin Lewin, *"Gene VII*", Oxford University Press, 2000.

MOLECULAR BIOLOGY	
Course Code: 24BMP515	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To describe about genes - their structure and function.
2. Define nucleic acid structure and the mechanics of replication, repair, transcription, and translation in bacteria, archaea and eukaryotes.
3. Techniques in molecular biology will be examined in lecture as necessary to understand experiments and concepts.
4. Recognize protein structure and function – especially protein interactions with nucleic acids – and post-translational events.
5. To know how current genomics projects (e.g., comparative and functional, and other '-omics') are altering our understanding of molecular biology.

COURSE LEARNING OUTCOME (CLO)

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

1. Explain how the structure and chemistry of nucleic acids relate to their functions, their relative stability, and their interactions with proteins.
2. Understand the regulation of protein and nucleic function by structure-function relationships and macromolecular interactions.
3. Know the complete structures of DNA/RNA components, the different forms of nucleic acids (A, B, Z) and the types of amino acids that mediate backbone and sequence-specific binding. Relate DNA structure to forms of DNA damage.
4. Compare & contrast mechanisms of DNA replication, repair, recombination, transcription, gene regulation, RNA processing and translation in bacteria & eukaryotes.
5. Explain how recent genomics and functional genomics advances are altering our views of molecular biology in, for example, eukaryotic transcription and chromatin function.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

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

COURSE CONTENTS

UNIT- I STRUCTURE OF NUCLEIC ACID

Structure of DNA - Different forms of DNA and RNA - Identification of DNA as genetic material by Griffith –Avery, McLeod and McCarty - Frankel and Singer - Hershey and Chase - Messel son and Stahl experiment.

UNIT- II DNA REPLICATION AND MUTATION

Semi-Conservative replication - replication of DNA in Eukaryotes - molecular basis of Mutation - classification of mutation.

UNIT- III GENE EXPRESSION AND REGULATION

Genetic code – transcription - prokaryotes and Eukaryotes - Post transcriptional modification - Translation in prokaryotes and Eukaryotes - Post translational modification - Gene Regulation - Lac operon model

UNIT -IV MENDELIAN GENETICS

Mendel's laws - monohybrid - dihybrid inheritance - multiple alleles - structure and organization of chromosome in prokaryote and Eukaryotes.

UNIT- V CROSSING OVER AND LINKAGE

Linkage - types of linkage -crossing over and their types- Recombination mapping by two point and three point text cross mapping in bacteria.

TEXT BOOKS:

Brown T.A., "Genetics- A molecular approach", Chapman & Hall, Third edition, 1999 2.Gardener, Simmons and Snustad, "Principles of Genetics", John Wiley & sons, 1991.

REFERENCE BOOKS:

1. Benjamin Lewin," Gene VII", Oxford University Press, 2000-.
2. Jain H.K.," Genetics – Principles, Concepts, and Implications", Oxford, 1999.
3. Powar C.B, "Genetics – VOL 1 & 2", Himalaya Publishing House, 2003.
4. John Ringo, "Fundamental Genetics", Cambridge, 2004.

BIOSENSOR, DRUG DESIGN AND DEVELOPMENT	
Course Code: 24BMP506	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Biochemistry ar Pharmacology	

COURSE OBJECTIVES (COs)

1. To provide a comprehensive understanding of biosensors and their applications.
2. To introduce the principles and methods of drug design and discovery.
3. To familiarize students with the types, components, and functions of biosensors.
4. To understand the stages and techniques involved in drug discovery and development.
5. To learn about the regulatory aspects and ethical considerations in drug design.

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. Describe the fundamental concepts of biosensors, their types, and applications.
2. Understand and explain the process of drug discovery and the stages of drug development.
3. Characterize biosensors based on their physical and chemical properties.
4. Apply techniques for target identification, lead compound discovery, and optimization.
5. Analyze the regulatory and ethical aspects of drug design and development.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to Biosensors

Introduction and classification of biosensors, components of biosensors, principles of biosensor technology, performance parameters of biosensors, applications in healthcare, environmental monitoring, and food industry. Types of biosensors: electrochemical, optical, thermal, and piezoelectric biosensors.

Unit-2: Drug Discovery: Processes and Techniques

Introduction to drug discovery, stages of drug discovery and development, target identification and validation, lead compound identification, high-throughput screening, structure-based drug design, and computer-aided drug design. Structure-activity relationships (SAR) and quantitative structure-activity relationships (QSAR). Techniques for target identification and validation, combinatorial chemistry, molecular modeling, docking studies, and pharmacophore modeling. In vitro and in vivo models for drug testing.

Unit-3: Techniques in Drug Discovery and Development

Methods for target identification and validation, techniques for lead optimization, combinatorial chemistry, molecular modeling, docking studies, and pharmacophore modeling. In vitro and in vivo models for drug testing, biomarker discovery, and translational research.

Unit-4: Pharmacokinetics and Pharmacodynamics

Principles of pharmacokinetics and pharmacodynamics, absorption, distribution, metabolism, and excretion (ADME) of drugs, dose-response relationships, therapeutic index, and drug efficacy and toxicity. Methods for evaluating drug metabolism and pharmacokinetics.

Unit-5: Regulatory Aspects and Ethical Considerations

Regulatory framework for drug development, clinical trials, phases of clinical trials, Good Clinical Practice (GCP), ethical issues in drug design and development, intellectual property rights, and patenting in pharmaceuticals. Case studies on successful drug development and regulatory approval.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. **Biosensors: Theory and Applications**: Donald G. Buerk, Technomic Publishing Co., 1995.
2. **Drug Design: Methodology, Concepts, and Mode-of-Action**: E.J. Ariëns, Academic Press, 1971.
3. **Pharmacokinetics and Pharmacodynamics of Biotech Drugs: Principles and Case Studies in Drug Development**: Bernd Meibohm, Wiley-VCH, 2006.

REFERENCE BOOKS

1. **Biosensor Principles and Applications**: Loic J. Blum and Pierre R. Coulet, CRC Press, 1991.
2. **Introduction to Drug Design and Development**: P.N. Patil, New Age International Publishers, 2008.
3. **Clinical Trials: A Practical Guide to Design, Analysis, and Reporting**: Duolao Wang and Ameet Bakhai, Remedica, 2006.
4. **Handbook of Biosensors and Biochips**: Robert S. Marks, Christopher R. Lowe, David C. Cullen, Howard H. Weetall, and Isao Karube, Wiley, 2007.
5. **Good Clinical, Laboratory and Manufacturing Practices: Techniques for the QA Professional**: Phillip A. Carson and Nigel J. Dent, CRC Press, 2007.

NPTEL COURSES

1. **Drug Delivery: Principles and Engineering** - NPTEL Course on Drug Delivery
2. **Biomedical Nanotechnology** - NPTEL Course on Biomedical Nanotechnology

RECOMBINANT DNA TECHNOLOGY	
Course Code: 24BMP611	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Elementary knowledge of molecular biology	

COURSE OBJECTIVES (COs)

1. To understand the ideal features of cloning vectors;
2. To analyze the role of various enzymes in cloning;
3. To demonstrate the expression of a desired gene in a vector;
4. To know the in vitro and in vivo cloning and selection of transformed clones;
5. To understand the application of genetic engineering.

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. The student will be able to understand the plasmid, phagemid, bacteriophages as cloning vectors and their application in gene mapping;
2. The student will know the application of various enzymes in cloning;
3. The student will be able to differentiate between cloning and expression vector;
4. The student will be able to demonstrate the methods used for selection of clones;
5. The student will be able to analyze the industrial application of genetic engineering and recombinant DNA technology.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				

CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Cloning Vectors:

Ideal features of cloning vectors – plasmids and bacteriophages – cloning vectors for E.coli ; pBR322, pUC vectors, M13 and other plasmid vectors – Cosmids, Phagemids.

Unit-2: Enzymes and Techniques For Cloning:

DNA modifying enzymes – ligases –homopolymer tails, linkers, adapters. Nucleic acid probe preparation; Radioactive and nonradioactive labels – Hybridization techniques – PCR; different types and applications.

Unit-3: Expression Vectors:

Expression vectors in prokaryotes – Expression vectors in Eukaryotes-Yeast cloning vectors – selectable markers for eukaryotes – SV40, Papilloma, Retrovirus, Baculoviral vectors – mammalian cell expression system – Gene transfer techniques – Agrobacterial plasmids – Ti plasmid and viral vectors – cloning in plants.

Unit-4: Genomic and cDNA Library:

Different strategies for in vitro and in vivo cloning – Preparation of rDNA, Preparation of cDNA and genomic DNA libraries – screening procedures – Direct methods-Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation /nutrition Indirect methods- Colony hybridization, Immunochemical detection Use of selectable and scorable genes: a) Selectable genes: Plants- npt ; Animals-TK b) Scorable genes: Plants-Gus; Animals-lux– gene transfer technologies – site-specific and oligonucleotide-directed mutagenesis.

Unit-5: Application of Gene Cloning:

Fusion protein- down-stream processing of recombinant proteins-Applications in medicine – Gene therapy- Diagnostics, pathogenesis, recombinant vaccines–humanized antibodies and their applications genetically modified food – bioremediation with recombinant microorganisms– forensic science.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXTBOOKS

1. Jeremy W. Dale, Malcolm von Schantz, Nicholas Plant. From Genes to Genomes: Concepts and Applications of DNA Technology-3rd Edition. 2011. Wiley-Blackwell.
2. T. A. Brown. Gene Cloning and DNA Analysis: An Introduction, 6th Edition. 2010. Blackwell.

REFERENCE BOOKS

1. Michael R. Green and Joseph Sambrook. Molecular Cloning: A Laboratory Manual (Fourth Edition). 2012. Cold Spring Harbor Press.
2. Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick. Lewin's GENES XI. 2012. Jones & Bartlett Learning.
3. Sandy B. Primrose and Richard Twyman. Principles of Gene Manipulation and Genomics. 2009. Wiley.

STATISTICAL COMPUTING WITH R

Course Code: 24BMP602	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Statistics ar Programming	

COURSE OBJECTIVES (COs)

1. To introduce the basics of statistical computing and data analysis using R.
2. To teach students how to manipulate and visualize data using R.
3. To provide an understanding of statistical models and inference techniques.
4. To develop skills in writing R scripts for statistical analysis.
5. To familiarize students with advanced statistical techniques 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. Understand and apply basic R programming concepts for statistical computing.
2. Manipulate and visualize data using R.
3. Perform statistical analysis and interpret results.
4. Develop and implement statistical models using R.
5. Apply advanced statistical techniques to real-world data.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			
CO3			✓		

CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to R and Basic Data Handling

Overview of R and RStudio, installation and setup, basic R commands, data types and structures, reading and writing data, data manipulation using dplyr, handling missing data, and basic data summarization.

Unit-2: Data Visualization

Introduction to data visualization, plotting systems in R, base graphics, ggplot2, creating various types of plots (histograms, scatter plots, box plots, etc.), customizing plots, and saving plots.

Unit-3: Descriptive Statistics and Probability Distributions

Descriptive statistics (mean, median, mode, variance, standard deviation, etc.), probability theory, common probability distributions (normal, binomial, Poisson, etc.), and generating random numbers from distributions, Sampling distributions, central limit theorem.

Unit-4: Statistical Inference

Hypothesis testing (t-tests, chi-square tests, ANOVA), confidence intervals, p-values, and power of a test. Performing hypothesis tests in R. Simple linear regression, multiple linear regression, model diagnostics, assumptions of regression analysis, logistic regression, and interpreting regression outputs. Implementing regression models in R.

Unit-5: Advanced Statistical Techniques

Introduction to advanced topics: time series analysis, principal component analysis (PCA), clustering methods (k-means, hierarchical clustering), machine learning basics, and implementing these techniques in R.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. **R for Data Science**: Hadley Wickham and Garrett Grolemund, O'Reilly Media, 2016.
2. **The Art of R Programming: A Tour of Statistical Software Design**: Norman Matloff, No Starch Press, 2011.
3. **Introduction to Statistical Learning**: Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, Springer, 2013.

REFERENCE BOOKS

1. **Advanced R**: Hadley Wickham, Chapman and Hall/CRC, 2015.
2. **R Cookbook**: Paul Teetor, O'Reilly Media, 2011.
3. **Applied Statistics and Probability for Engineers**: Douglas C. Montgomery and George C. Runger, Wiley, 2010.
4. **Statistics with R Programming**: Manas A. Pathak, Springer, 2014.
5. **The R Book**: Michael J. Crawley, Wiley, 2012.

NPTEL COURSES

1. **Introduction to R Software** - NPTEL Course on Introduction to R
2. **Introduction to Data Analytics** - NPTEL Course on Data Analytics
3. **Statistical Inference** - NPTEL Course on Statistical Inference
4. **Data Science for Engineers** - NPTEL Course on Data Science

NANOTECHNOLOGY AND CLINICAL SCIENCE	
Course Code: 24BMP603	**Continuous Evaluation: 40 Marks**
Credits: 3	**End Semester Examination: 60 Marks**
L T P: 3 0 0	
Prerequisite: NIL	

COURSE OBJECTIVES (CO)

1. To understand fundamental knowledge of the Nanoscience and related fields
2. To make the students acquire an understanding the Nanoscience and Applications.
3. To gain knowledge in broad outline of Nanoscience and Nanotechnology.
4. To examine application of nanotechnology in Biomedical.

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:

1. Students will be able to learn about the background of Nanoscience;
2. Understand nanomaterial can be used for a diversity of analytical medicinal rationales;
3. Gain knowledge of nucleic acid-based Nanomaterial; Liposphere in drug target and delivery;
4. Application of nanotechnology in Biomedical and Life Sciences.

MAPPING MATRIX OF CO'S AND CLO'S:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	
CO4				✓

COURSE CONTENTS:

UNIT I- Introduction: Nanotechnology – definition and scope, nanobiotechnology- recent development and applications, Bioconjugation mediated drug delivery, carbon nanotubes – types and their biomedical applications, Immunotoxin, personalized nanomedicine.

UNIT II- Biopolymer: Biopolymer- classification and types, polymer nanofibers – electrospinning method and their biomedical Applications, biocompatible polymer and their application in tissue engineering, Biodegradable polymer derived from amino acid, Biocompatible nanomaterials, PLA and PLGA Based nanoparticulate delivery system.

UNIT III- Synthesis of Nanomaterials and nano formulations:

Top down and bottom-up approach forsynthesis of nanomaterials. Synthesis of nanomaterials using physical, chemical and biological methods. Characterization techniques for nanomaterials. Nano-bio-assemblies: Different types of inorganic materials used for the synthesis of hybrid nano-bio-Assemblies. Formulation of nanocrystals, nano emulsions, polymeric micelles

UNIT IV- Nucleic acid based Nanomaterials:

DNA based artificial nanostructures; Fabrication, properties and application-Nucleic acid engineered nanomaterials and their applications. Protein patterning for applications in biomaterials. DNA lipoplexes – Lipofection efficiency *In Vitro* and *In Vivo*, Polymer controlled delivery of therapeutic nucleic acid.

UNIT V- Nanotechnology in Biomedical and Life Sciences:

Diagnosis using nanomaterials, Nanoparticles for bioanalytical applications, Nanoparticles for MRI,X Ray, ultrasonography, gamma ray imaging, Approach to developing nanomedicines. Various kindsof nano-systems in use. Nanodrug administration nano-devices for drug delivery, Introductionto the potentials, applications and challenges of nanomedicine. Nanomedicine and tissue engineering, nano-bio-machines and nano-robots, engineering, nano-bio-machines and nano-robots.

TEXT BOOKS/ REFERENCE BOOKS/ NPTEL RESOURCES

TEXT BOOKS

1. 1.Charles P. Poole Jr. and Franks. J. Qwens (2003) Introduction to Nanotechnology. John Wiley and Sons.
2. 2.Ehud Gazit (2007) Plenty of Room for Biology at the Bottom: An Introduction to Bio nanotechnology. Imperial college Press

3. 3.Bharat Bhushan (2007) Springer Handbook of Nanotechnology. Springer Verlag.
4. 4.Challa S., S. R. Kumar, J. H. Carola (2006) Nanofabrication towards biomedical application: Techniques, tools, Application and impact. John Wiley and sons.
5. 5.Robert A. Freitas Jr (2003) Nanomedicine, Vol. I: Basic Capabilities.
6. 6.Understanding nanomaterials Malikat. S. Johl 2018

REFERENCE BOOKS

1. 1.Neelina H. Malsch (2005) Biomedical Nanotechnology. Taylor and Francis. CRC press.
2. 2.Patrick Boisseau, Marcel Lahmani (2009) Nanoscience: Nanobiotechnology and Nanobiology. Springer Publishers.
3. 3.Ralph S. Greco, Fritz B. Prinz, R. Lane Smith (Editors) (2004) Nanoscale Technology in Biological Systems. CRC Press
4. 4.Harry F. Tibbals (2010) Medical Nanotechnology and Nanomedicine. CRC Press.
5. 5.Greco R. S., Prinz F. B., and Smith, R. L. (eds.), "Nanoscale Technology in Biological Systems", CRC Pres, ISBN: 0849319404, (2005).
6. 6.Ratner, M. and Ratener, D, "Nanotechnology A Gentle Introduction to the Next BigIdea", Prentice Hall, ISBN: 0131014005, (2003).

NPTEL RESOURCES

1. 1.Nanotechnology– NPTEL Course on Basics of Nanotechnology
2. 2.Nanotechnology for Biomedical- NPTEL Course for Biomedical Nanotechnology

DEEP LEARNING & MACHINE LEARNING IN HEALTH CARE	
Course Code: 24BMP604	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Machine Learning and Healthcare Systems	

COURSE OBJECTIVES (COs)

1. To introduce the fundamental concepts of machine learning and deep learning.
2. To apply machine learning techniques to healthcare data.
3. To understand the role of deep learning in medical image analysis.
4. To explore various healthcare applications of machine learning and deep learning.
5. To understand the ethical and regulatory aspects of AI in healthcare.

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 basics of machine learning and deep learning.
2. Apply machine learning algorithms to healthcare datasets.
3. Develop and evaluate deep learning models for medical image analysis.
4. Explore various real-world applications of AI in healthcare.
5. Analyze ethical and regulatory challenges in applying AI to healthcare.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			

CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to Machine Learning and Deep Learning

Overview of machine learning and deep learning, types of machine learning (supervised, unsupervised, reinforcement learning), introduction to neural networks, deep learning architectures (CNN, RNN, LSTM, GANs), and software tools (TensorFlow, Keras, PyTorch).

Unit-2: Machine Learning in Healthcare

Introduction to healthcare data (EMRs, genomic data, medical images), preprocessing and cleaning healthcare data, feature extraction and selection, supervised learning algorithms (regression, decision trees, SVM, k-NN), unsupervised learning (clustering, PCA), and evaluating model performance (confusion matrix, ROC curve, cross-validation).

Unit-3: Deep Learning for Medical Image Analysis

Introduction to medical image modalities (X-ray, CT, MRI, Ultrasound), convolutional neural networks (CNN) for image classification, segmentation, and detection, transfer learning, data augmentation techniques, evaluating deep learning models, and case studies on medical image analysis.

Unit-4: Applications of AI in Healthcare Unit Name

Predictive modeling for disease diagnosis and prognosis, personalized medicine, drug discovery and development, natural language processing (NLP) for clinical text analysis, wearable devices and health monitoring, and AI in telemedicine and remote patient monitoring.

Unit-5: Ethical and Regulatory Aspects

Ethical considerations in AI (bias, fairness, transparency), patient privacy and data security, regulatory frameworks (FDA, EMA) for AI-based medical devices, AI explainability and interpretability, and future trends and challenges in AI in healthcare.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. **Deep Learning**: Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, 2016.
2. **Machine Learning for Healthcare**: Kevin Murphy, MIT Press, 2020.
3. **Healthcare Data Analytics**: Chandan K. Reddy and Charu C. Aggarwal, CRC Press, 2015.

REFERENCE BOOKS

1. **Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow**: Aurélien Géron, O'Reilly Media, 2019.
2. **Deep Learning for Medical Image Analysis**: S. Kevin Zhou, Hayit Greenspan, and Dinggang Shen, Academic Press, 2017.
3. **Artificial Intelligence in Healthcare**: Adam Bohr and Kaveh Memarzadeh, Academic Press, 2020.
4. **Applied Predictive Modeling**: Max Kuhn and Kjell Johnson, Springer, 2013.
5. **Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes**: Arjun Panesar, Apress, 2019.

NPTEL COURSES

1. **Deep Learning** - NPTEL Course on Deep Learning
2. **Introduction to Machine Learning** - NPTEL Course on Machine Learning
3. **Artificial Intelligence: Knowledge Representation and Reasoning** - NPTEL Course on AI
4. **Biomedical Signal Processing** - NPTEL Course on Biomedical Signal Processing

BIOINFORMATICS LAB	
Course Code: 24BM553	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: Nil	

COURSE OBJECTIVES (CO)

1. To provide knowledge of Biological Databases.
2. To study basics and advanced concepts of bioinformatics.
3. To understand Computational biology approaches to analyse the genomes and proteomes.
4. Basic understanding of structural bioinformatics and molecular modeling.

COURSE LEARNING OUTCOMES (CLO)

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

1. To use and develop bioinformatics programs for comparing & analyzing biological sequence data to identify probable function.
2. Gain working knowledge of these computational tools and methods
3. To understand the methodologies used for database searching, and determining the accuracies of database search.
4. Analysis and development of models for better interpretation of biological data to extract knowledge.

MAPPING COURSE OBJECTIVES & COURSE LEARNING OUTCOMES

CLOs / Cos	CLO1	CLO2	CLO3	CLO4
CO1	✓			
CO2		✓		
CO3			✓	

CO4				✓

LIST OF EXPERIMENTS

1. Searching of biological databases and its applications.
2. To retrieve sequence in fasta format from NCBI.
3. To search the Research Literature from PubMed database.
4. Identification of related sequences using BLAST algorithm.
5. Draw a threshold dot plot from two input protein sequences using Dotmatcher (EMBOSS).
    1. Dot Plot for two human hemoglobin and mouse hb protein
    2. Dot Plot for human hemoglobin and myoglobin proteins
6. Create an optimal global alignment of two sequences using the Needleman-Wunsch algorithm using stretcher program.
7. Identify local similarities between two sequences using a rigorous algorithm based on the LALIGN application.
8. Multiple sequence alignment of protein sequences using Clustal Omega
9. Phylogenetic Tree construction of given protein sequences for establishing evolutionary relationships.
10. To visualize the three-dimensional structure of selected protein using 3D visualization bioinformatics softwares.
11. To validate the three-dimensional structure of protein using Ramachandran Plot analysis.
12. To identify and study Receptor-ligand interactions of a given 3D complex using bioinformatics softwares.

TEXT BOOKS:

1. Pevzner, P.A., “Computational Molecular Biology”, Prentice Hall, 2004.
2. Orengo C. A, Jones D.T., Thornton J. M., “Bioinformatics: Genes, Proteins and Computers”, Roultledge Publisher, 2003.
3. Teresa Attwood, “Introduction to Bioinformatics Paperback”, Pearson Education, 2007.

REFERENCE BOOKS:

3. Baxevanis A. D., Ouellette B. F. “Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins”, John Wiley and Sons, 2004.

4. Arthur M. Lesk, “Introduction to Bioinformatics-Fourth Ed.”, Oxford University Press, 2018.

MATHEMATICAL MODELING AND SIMULATION WITH MATLAB

Course Code: 24BMP702	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Basic Knowledge of Mathematics ar Programming	

COURSE OBJECTIVES (COs)

1. To introduce the fundamental concepts of mathematical modeling and simulation.
2. To develop skills in formulating mathematical models for real-world problems.
3. To teach students how to use MATLAB for modeling and simulation.
4. To provide an understanding of various simulation techniques.
5. To apply mathematical models and simulations to engineering and scientific problems.

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 principles of mathematical modeling and simulation.
2. Formulate mathematical models for real-world problems.
3. Utilize MATLAB for developing and analyzing mathematical models.
4. Apply various simulation techniques to study the behavior of models.
5. Solve engineering and scientific problems using mathematical modeling and simulation.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			

CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

Unit-1: Introduction to Mathematical Modeling and MATLAB Basics: Introduction to mathematical modeling: Types of models (deterministic, stochastic, continuous, discrete), steps in model development, validation, and verification of models, Applications of mathematical modeling in various fields, Introduction to MATLAB environment: Basic commands and functions, variables and data types, scripts and functions, control statements (if, for, while), and plotting and visualization in MATLAB.

Unit-2: Differential Equations and Dynamic Systems: Modeling with ordinary differential equations (ODEs): Initial value and boundary value problems, Numerical methods for solving ODEs: Euler's method, Runge-Kutta methods, Modeling dynamic systems and stability analysis.

Unit-3: Discrete Event Simulation and Optimization Techniques: Introduction to discrete event simulation: Monte Carlo simulation, random number generation, and statistical analysis of simulation results, Applications of discrete event simulation, Introduction to optimization: Linear and nonlinear programming, constrained and unconstrained optimization, Optimization techniques in MATLAB.

Unit-4: Parameter Estimation and Advanced Modeling Techniques: Parameter estimation methods: Least squares, maximum likelihood estimation, Case studies in optimization and parameter estimation, Advanced modeling techniques: Partial differential equations (PDEs) and their applications, finite element method (FEM), finite difference method (FDM).

Unit-5: System Identification and Advanced Topics in Simulation: System identification: Methods and applications, Advanced topics in simulation: Agent-based modeling, neural network modelling, Integration of simulation techniques for comprehensive modeling and problem-solving.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

4. "Mathematical Modeling and Simulation: Introduction for Scientists and Engineers" by Kai Velten, Wiley, 2009.
5. "MATLAB for Engineers" by Holly Moore, Pearson, 2017.
6. "Applied Numerical Methods with MATLAB for Engineers and Scientists" by Steven C. Chapra, McGraw-Hill Education, 2017.

REFERENCE BOOKS

4. "MATLAB: A Practical Introduction to Programming and Problem Solving" by Stormy Attaway, Butterworth-Heinemann, 2016.
5. "Introduction to the Numerical Solution of Differential Equations" by Douglas Faires, Academic Press, 1996.
6. "Simulation Modeling and Analysis" by Averill Law, McGraw-Hill Education, 2014.

NPTEL COURSES

4. Mathematical Modeling and Simulation
5. Introduction to MATLAB
6. Numerical Methods using MATLAB

MATHEMATICAL MODELING AND SIMULATION WITH MATLAB LAB	
Course Code: 24BMP752	Continuous Evaluation: 60 Marks
Credits: 1	End Semester Examination: 40 Marks
L T P : 0 0 2	
Prerequisite: "Mathematical Modeling and Simulation with MATLAB" lecture course	

COURSE OBJECTIVES (COs)

1. To provide hands-on experience with MATLAB for modeling and simulation.
2. To reinforce theoretical concepts through practical experiments.
3. To develop skills in writing and debugging MATLAB scripts and functions.
4. To apply MATLAB to solve real-world engineering and scientific problems.
5. To enable students to analyze and interpret simulation results.

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. Write and execute MATLAB scripts and functions for mathematical modeling.
2. Implement numerical methods for solving differential equations in MATLAB.
3. Conduct simulations to study the behavior of dynamic systems.
4. Apply optimization techniques using MATLAB.
5. Analyze and interpret the results of simulations and experiments.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

CLOs / COs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				

CO2		✓			
CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

1. **Introduction to MATLAB:** Explore the basics of MATLAB environment, writing scripts, and plotting simple graphs.
2. **Data Types and Structures:** Work with various data types (arrays, matrices, cell arrays) and manipulate data**.**
3. **Control Statements and Loops:** Implement control statements and loops, and create custom functions.
4. **Plotting and Visualization:** Create, customize, and export various types of plots in MATLAB.
5. **Numerical Methods for Solving ODEs:** Implement Euler's method and use built-in functions to solve ODEs.
6. **Simulation of Dynamic Systems:** Model and simulate the behavior of dynamic systems using ODE solvers.
7. **Discrete Event Simulation:** Implement Monte Carlo simulation and analyze random processes.
8. **Optimization Techniques:** Apply basic optimization techniques and solve real-world problems using MATLAB.
9. **Parameter Estimation:** Use curve fitting and regression analysis for parameter estimation and validation.
10. **Advanced Modeling Techniques:** Model PDEs using finite difference method and simulate with MATLAB PDE toolbox.

TEXTBOOKS/ REFERENCE BOOKS/NPTEL RESOURCES

TEXT BOOKS

1. "MATLAB for Engineers" by Holly Moore, Pearson, 2017.
2. Applied Numerical Methods with MATLAB for Engineers and Scientists" by Steven C. Chapra, McGraw-Hill Education, 2017.

REFERENCE BOOKS

1. "MATLAB: A Practical Introduction to Programming and Problem Solving" by Stormy Attaway, Butterworth-Heinemann, 2016.
2. "The MATLAB Handbook" by Kevin D. Donohue, Springer, 2018.

NPTEL COURSES

1. Mathematical Modeling and Simulation
2. Introduction to MATLAB
3. Numerical Methods using MATLAB
4. Optimization Techniques

BIOETHICS, BIOSAFETY AND IPR	
Course Code: 24BMP703	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Elementary knowledge of physics and human physiology	

COURSE OBJECTIVES(CO)

6. To recognize the students will be able to know about the legal and ethical principles in health care settings.
7. To gain knowledge about the medical standards that to be followed in hospitals.
8. Professional ethics to be followed by Biomedical Engineers.
9. Patient safety and regulatory aspects followed in hospitals
10. Intellectual Property Rights.

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:

6. Legal and professional guidelines for the health professions.
7. Social responsibility in healthcare systems.
8. Bioethics and engineer's role.
9. Medical device maintenance.
10. Understand safety aspects.

MAPPING MATRIX OF CO'S AND CLO'S:

CLOs / Cos	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓				
CO2		✓			

CO3			✓		
CO4				✓	
CO5					✓

COURSE CONTENTS

UNIT I INTRODUCTION TO MEDICAL ETHICS: Definition of Medical ethics, Scope of ethics in medicine, international code of ethics for occupational health professionals, Ethical Theories -- Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Role of ethics in Health care workplace – Autonomy, Non-Malfeasance, Beneficence, Veracity, Justice, OSHA, Decision Model for Healthcare Dilemmas Applications of Plus decision-making model.

UNIT II SOURCES OF MEDICAL LAW AND ETHICS: Nature and sources of medical ethics, Sources of medical law. Consent, Confidentiality and Clinical Negligence: Consent to Treatment, Confidentiality and Clinical Negligence.

UNIT III MEDICAL DEVICE SAFETY: Shared Responsibility for Medical device safety. WHO – International Health Regulations (IHR), Stages of regulatory control of medical devices, Ethics committee- its members and functions, Global Harmonization Task Force (GHTF). Quality systems requirement –ISO, Voluntary and mandatory standards, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device, International Standards and safety code

UNIT IV Biosafety :

Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment. General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc;

UNIT V - INTELLECTUAL PROPERTY RIGHTS: Intellectual property rights - patents and methods of application of patents - legal implications- objectives of the patent system - basic principles and general requirements of patent law-biotechnological inventions and patent law - patentable subjects.

TEXTBOOKS:

5. William Charney, “Handbook of Modern Hospital Safety’’, CRC Press, 2nd Edition, 2009.

6. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, “Inspection of Medical Devices: For Regulatory Purposes”, Springer Nature, 2018.

7. Domiel A Vallero , “Biomedical Ethics for Engineers”, Elsevier Pub.1st Edition, 2007.

8. Singh.K, “Intellectual Property rights in Biotechnology”, , BCIL, New Delhi.

REFERENCE BOOKS:

1. Eileen E.Morrison, “Ethics in Health Administration: A Practical Approach for Decision Makers’’,Jonnes and Bartletts’ Publication, 2nd Edition, 2011.

5. Robert M Veatch, “Basics of Bio Ethics’’, Prentice- Hall, Inc., 2nd Edition, 2003.

6. Physical Environment Online: A Guide to The Joint Commission‘s Safety Standards is published by HCPro, Inc., 2010.

7. Joint Commission Accreditation Standards for Hospitals ,2nd Edition, 2003.

ADVANCE MEDICAL IMAGING	
Course Code: 24BMP704	Continuous Evaluation: 40 Marks
Credits: 3	End Semester Examination: 60 Marks
L T P : 3 0 0	
Prerequisite: Knowledge of medical imaging	

COURSE OBJECTIVES (COs)

1. To provide an in-depth understanding of various advanced imaging modalities used in medical diagnostics and their clinical applications.
2. To explore the principles, instrumentation, and advancements in digital radiography, thermography, optical imaging, and nuclear imaging.
3. To impart knowledge on radiation safety, protection strategies, and regulatory requirements in medical imaging.
4. To understand the biological effects of radiation and the principles of radiation protection.
5. To develop practical skills in operating imaging equipment, analyzing images, and applying safety protocols in clinical settings.

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. Demonstrate proficiency in the principles, techniques, and applications of angiography, fluoroscopy, mammography, and digital radiography.
2. Analyze and utilize thermography equipment and optical imaging techniques for clinical applications.
3. Evaluate the instrumentation, clinical applications, and characteristics of SPECT/PET and radiopharmaceuticals.
4. Apply radiation protection concepts, understand different types of radiation and their biological effects, and comply with regulatory standards.
5. Implement radiation protection strategies, understand occupational exposure limits, and assess factors affecting radiosensitivity.

MAPPING BETWEEN COURSE OBJECTIVES (COs) AND COURSE LEARNING OUTCOMES (CLOs)

COs \ CLOs	CLO1	CLO2	CLO3	CLO4	CLO5
CO1	✓	✓			
CO2	✓	✓	✓		
CO3				✓	✓
CO4				✓	✓
CO5	✓	✓	✓	✓	✓

COURSE CONTENTS

Unit 1: Radiology and Digital Imaging: Angiography: Principles, techniques, and clinical applications, Fluoroscopy: Instrumentation, real-time imaging, and clinical uses, Mammography: Techniques, equipment, and breast cancer screening, Digital Radiography: Flat-panel detectors, image acquisition, and processing, C-ARM & Dental X-Ray: Portable imaging systems and applications in dentistry, Endovascular Robotics: Integration with imaging systems, applications in minimally invasive procedures, Principles of Radiation Dosimetry: Measurement, calculation, and management of radiation dose.

Unit 2: Thermography and Optical Imaging: Physics of Thermography: Infrared radiation, heat transfer, and thermographic imaging, Infrared Detectors and Sensors: Types, principles of operation, and applications in medical imaging, Thermography Equipment: Design, components, and clinical applications, Advantages of Optical Imaging: Non-invasiveness, resolution, and contrast, Optical Coherence Tomography (OCT): Principles, instrumentation, and clinical applications, Emission Tomography: Basics of radioactivity, types of detectors, and fundamental principles, Anger Scintillation Camera: Construction, working principles, and clinical use.

Unit 3: Nuclear Imaging and Radiopharmaceuticals: SPECT/PET Instrumentation: Design, functionality, and image reconstruction, Clinical Applications of SPECT/PET:

Oncology, cardiology, neurology, and other fields, Radiopharmaceuticals Characteristics: Types, properties, and mechanisms of localization, Applications of Radiopharmaceuticals: Diagnostic and therapeutic uses, Gamma Camera: Construction, working principles, and performance characteristics, Development of Betatron, Cobalt-60 Machine, Gamma Knife, Medical Linear Accelerator Machine, Cyberknife

Unit 4: Radiation Safety and Regulatory Requirements: Radiation Protection: Concepts, need, and safety measures, Types of Radiation: Ionizing and non-ionizing radiation, sources, and biological effects, Stochastic and Non-Stochastic Effects: Differences, examples, and implications, Safety Limits and Risk Factors: Dose limits, risk assessment, and management, Regulatory Bodies: International Commission on Radiation Protection (ICRP) and Atomic Energy Regulatory Board (AERB), Responsibilities and Safety Standards: Organizational structure, regulations, and compliance

Unit 5: Biological Effects and Radiation Protection Strategies: Introduction to Radiation Protection: Goals, principles, and implementation, Limits for Radiation Exposure: ALARA principle, maximum permissible dose, special considerations for pregnancy and children, Occupational Exposure Limits: Standards for healthcare workers and the public, Biological Effects of Radiation: Direct and indirect actions, deterministic and stochastic effects, somatic and genetic impacts, Chronic Exposure and LD50: Long-term exposure effects and lethal dose 50%, Factors Affecting Radiosensitivity: Tissue type, age, and other variables affecting sensitivity to radiation

TEXTBOOKS

1. Introduction to Biomedical Imaging-Andrew G. Webb, Wiley-IEEE Press

2. Fundamentals of Medical Imaging -Paul Suetens, Cambridge University

REFERENCE BOOKS

1.The essential physics of medical imaging-. J. T. Bushberg, J.A. Seibert, E.M. Leidholdt Jr., J. Boone,LWW

2. Essentials of Ultrasound. – Michael R. Williamson, Saunders