Syllabus

For

Bachelor of Technology (B-Tech.) Programme

in

Biomedical Engineering

(as per NEP 2020)

Approved by 112th Academic Council

School of Technology

North-Eastern Hill University, Mawkynroh

Umshing, Shillong – 793 022

Year 2024-2025

OBJECTIVES OF B.TECH. PROGRAM IN BME

PROGRAM EDUCATIONAL OBJECTIVES (PEOS):

1. To understand and apply the concepts of Engineering and Sciences including Biology in Medicine that will build career and pursue higher studies in Biomedical Engineering.

2. To identify, analyse and solve the problems with novelty and updated knowledge in the development of product/process/technique related to healthcare to meet the societal demands.

3.To make graduates proficient in written and oral communications in their professions and to impart value added continuing education for sustained growth

4.To apply the acquired practical skills and training for effective teaching, research, development and entrepreneurship in biomedical field.

LEARNING PROGRAM OUTCOMES (POS):

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **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.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **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.
5. **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.
6. **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.
7. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
8. **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.
9. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

10. **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.
11. **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.
12. **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.

PROGRAM SPECIFIC OUTCOMES (PSOS):

1. The students should be able to identify, formulate and analyze complex problems in the healthcare sector.
2. The students should be able to address research problems and develop biomedical products with desired specifications.
3. The students should have the capability to demonstrate professional ethics and concern for societal well-being.

COURSE STRUCTURE AND THEME

I. DEFINITION OF CREDIT

1 Hr. Lecture (**L**) per week	**1 credit**
1 Hr. Tutorial (**T**) per week	**1 credit**
2 Hours Practical (**P**)	**1 credit**

II. RANGE OF CREDITS

In the line of Model Curriculum and Credit Framework for Bachelor of Technology (B.Tech.) (approved by the Academic Council in its 110th meeting held on June 28th, 2023) and following the guideline of AICTE (Regulatory body for Professional Programmes), the total credit of Four-years Under Graduate degree program (B.Tech) in Technology is kept 160 credits. While each semester credit is kept 20.

The Same credit system will be followed for other B.Tech. offering departments, like- Electronics and Communication, Information Technology, Energy Engineering, Electrical Engineering, Mechanical Engineering, Civil Engineering etc. under the SOT, NEHU.

III. STRUCTURE OF UG PROGRAM IN TECHNOLOGY

The structure of UG program in Technology shall have essentially the following categories of courses with the breakup of credits as given:

S. No.	Category	Breakup of Credits	Paper
1	Humanities and Social Science Courses	10	04
2	Basic Science Courses	18	06
3	Engineering Science Courses	15	05
4	Professional Core Courses (Branch specific)	71	24
5	Professional Elective Courses (Branch specific)	12	03
6	Open Elective Courses (from Humanities, Technical Emerging or other Subjects)	9	03
7	Project work, Seminar and Internship in Industry or elsewhere	25	04
8	Audit Courses	Non credit	03
	IDEA laboratory, Environmental Sciences, Indian Constitution,		
Total		**160**	**52**

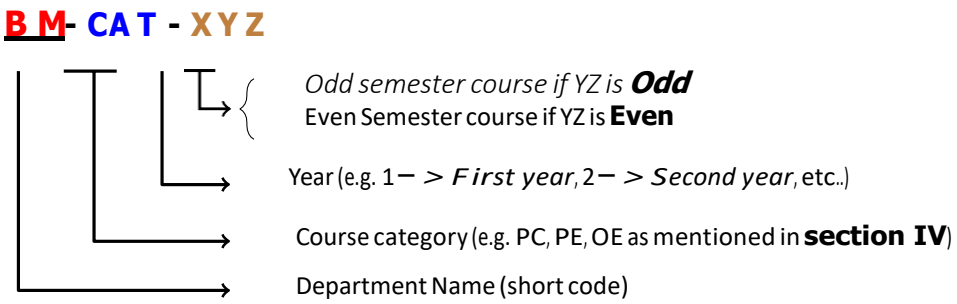
IV. COURSE CODE AND DEFINITION

Course code	Definition
L	Lecture
T	Tutorial
P	Practical
C	Credit
BS	Basic Sciences Courses
ES	Engineering Sciences Courses
HSM	Humanities & Social Science including Management Courses
PC	Professional Core Courses
PE	Program Elective Courses
OE	Open Elective Courses
LC	Laboratory Courses
AU	Audit Courses

V. COURSE LEVEL CODING SCHEME

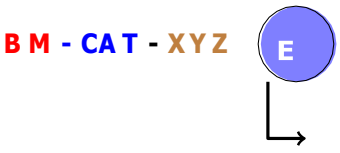
Course Coding for Core Papers:

The paper code starts with department name followed by Course Category for identifying the level of the course. Digit at hundred's place signifies the year in which course is offered and remaining two-digits represents semester number (odd numbers for the odd semester courses and even numbers for even semester courses) e.g.:



Course Coding for Elective Papers:

The format remains same as the core papers but with an additional number to represent the elective number in the list e.g.:



Elective paper number from the available list

VI. INDUCTION PROGRAM

The essence and details of Induction Program can also be understood from the "Detailed Guide on Students Induction program" as available on AICTE Portal.

Induction Program (Mandatory)	Three-week duration
Induction program for students to be offered right at the start of the first year.	Physical activity
	Creative arts
	Universal Human Values
	Proficiency Modules
	Literary
	Lectures by Eminent People
	Visits to local Areas
	Familiarization to Dept./Branch & Innovations

Table of Contents

1. B.Tech. (BME) Syllabus Scheme

1. 1. SEMESTER: I

Branch: Biomedical Engineering Year: 1 Semester: I

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
3 WEEKS COMPULSORY INDUCTION PROGRAM (UHV-I)											
Theory Courses			L	T	P	TA	CT	ST	ESE	TOT	
1	BM-HSM-101	Universal Human Values- II	3	0	0	15	15	30	45	75	3
2	BM-BS- 103	Engineering Mathematics	3	1	0	20	20	40	60	100	4
3	BM-ES-105	Programming for Problem Solving	3	1	0	20	20	40	60	100	4
4	BM-PC- 107	Human Anatomy and Physiology	4	0	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
5	BM-ES-LC-109	Computer Programming Laboratory	0	0	4	10	10	20	30	50	2
6	BM-PC-LC-111	Medical Technology Laboratory	0	0	4	10	10	20	30	50	2
7	BM-PC-LC-113	Biomedical Engineering workshop	0	0	2	5	5	10	15	25	1
Audit course											
8	BM-AU- 115	IDEA Workshop	0	-	4	20	30	50	-	50*	0
Total			13	2	14	100	100	200	300	500	20

* For audit course, only continuous assessment will be conducted. Passing this course is mandatory for students.

L-Lecture	T-Tutorial	P-Practical	TA-Assessment by Teachers
CT-Class Test	ST-Sub -Total	ESE-End Semester Evaluation	TOT-Total
Contact Hours: 29		**Total Marks: 500**	**Total Credits: 20**

1.2. SEMESTER: II

Branch: Biomedical Engineering Year: 1 Semester: II

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Courses			L	T	P	TA	CT	ST	ESE	TOT	
1	BM-HSM-102	Professional Communication Skills	3	0	0	15	15	30	45	75	3
2	BM-BS- 104	Engineering Physics	3	0	0	15	15	30	45	75	3
3	BM-ES-106	Basic Electrical Engineering	3	0	0	15	15	30	45	75	3
4	BM-PC-108	Biochemistry and Microbiology	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
5	BM-BS-LC-110	Engineering Physics Laboratory	0	0	4	10	10	20	30	50	2
6	BM-ES-LC-112	Basic Electrical Engineering Laboratory	0	0	4	10	10	20	30	50	2
7	BM-PC-LC-114	Biochemistry and Microbiology laboratory	0	0	4	10	10	20	30	50	2
8	BM-HSM-LC-116	Professional Communication Skills Laboratory	0	0	2	5	5	10	15	25	1
Audit course											
9	BM-AU-118	Environmental Science	0	-	4	20	30	50	-	50*	0
Total			12	1	18	100	100	200	300	500	20

* For audit course, only continuous assessment will be conducted. Passing this course is mandatory for students.

L-Lecture	T-Tutorial	P-Practical	TA-Assessment by Teachers
CT-Class Test	ST-Sub -Total	ESE-End Semester Evaluation	TOT-Total
Contact Hours: 31		**Total Marks: 500**	**Total Credits: 20**

The entry and exit after first year will be as per RC -20.

1.3. SEMESTER: III

Branch: Biomedical Engineering Year: 2 Semester: III

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S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Courses			L	T	P	TA	CT	ST	ESE	TOT	
1	BM-HSM-201	Engineering Economics and Management	3	0	0	15	15	30	45	75	3
2	BM-BS-203	Engineering Chemistry	3	0	0	15	15	30	45	75	3
3	BM-ES-205	Basic Electronics	3	1	0	20	20	40	60	100	4
4	BM-PC-207	Biomedical Instrumentation-I	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
5	BM-BS-LC-209	Engineering Chemistry Laboratory	0	0	4	10	10	20	30	50	2
6	BM-PC-LC-211	Biomedical Instrumentation-I Laboratory	0	0	4	10	10	20	30	50	2
7	BM-PC-LC-213	Engineering Design and 3D Printing Laboratory	0	0	4	10	10	20	30	50	2
Audit course											
8	BM-AU-215	Indian Constitution	0	-	4	20	30	50	-	50*	0
Total			14	2	12	100	100	200	300	500	20

* For audit course, only continuous assessment will be conducted. Passing this course is mandatory for students.

L-Lecture	T-Tutorial	P-Practical	TA-Assessment by Teachers
CT-Class Test	ST-Sub -Total	ESE-End Semester Evaluation	TOT-Total
Contact Hours: 28		Total Marks: 500	Total Credits: 20

1.4. SEMESTER: IV

Branch: Biomedical Engineering Year: 2 Semester: IV

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Courses			L	T	P	TA	CT	ST	ESE	TOT	
1	BM-BS- 202	Statistics and Random Processes	3	1	0	20	20	40	60	100	4
2	BM-PC-204	Biomedical Instrumentation-II	3	1	0	20	20	40	60	100	4
3	BM-PC-206	Signals and Systems	3	1	0	20	20	40	60	100	4
4	BM-PC-208	Biomaterials	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
5	BM-PC-LC-210	Biomaterials Laboratory	0	0	4	10	10	20	30	50	2
6	BM-PC-LC-212	Biomedical Instrumentation-II Laboratory	0	0	4	10	10	20	30	50	2
Total			12	4	8	100	100	200	300	500	20

L-Lecture	T-Tutorial	P-Practical	TA-Assessment by Teachers
CT-Class Test	ST-Sub -Total	ESE-End Semester Evaluation	TOT-Total
Contact Hours: 24		Total Marks: 500	Total Credits: 20

The entry and exit after second year will be as per RC -20.

1.5. SEMESTER: V

Branch: Biomedical Engineering Year: *3* **Semester: V**

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Courses			L	T	P	TA	CT	ST	ESE	TOT	
1	BM-PC-301	Artificial Intelligence in Healthcare	3	1	0	20	20	40	60	100	4
2	BM-PC-303	Biomechanics and Rehabilitation Engineering	3	1	0	20	20	40	60	100	4
3	BM-PC-305	Biomedical Signal Processing	3	1	0	20	20	40	60	100	4
4	BM-PE-307E	Program Elective-I	3	1	0	20	20	40	60	100	4
Practical/Design/Laboratory/Seminar											
5	BM-PC-LC- 309	Biomechanics and Rehabilitation Engineering Laboratory	0	0	4	10	10	20	30	50	2
6	BM-PC-LC-311	Biomedical Signal Processing Laboratory	0	0	4	10	10	20	30	50	2
Total			12	4	8	100	100	200	300	500	20

Program Elective-I (BM-PE-307E)		
Sl. No.	**Course Code**	**Course Title**
1.	BM -PE-3071	Measurement and Control Systems
2.	BM -PE-3072	Analytical Instruments and Techniques
3.	BM -PE-3073	Bio-transport Process
4.	BM -PE-307E*	MOOCs as per NEHU regulations

*E: varies from 1-9; 1-3: subjects offered by department, 4-9: MOOCs courses. A student may undertake MOOCs courses approved by the department following the provision laid down in RC-20.

L-Lecture	T-Tutorial	P-Practical	TA-Assessment by Teachers
CT-Class Test	ST-Sub -Total	ESE-End Semester Evaluation	TOT-Total
Contact Hours: 24		**Total Marks: 500**	**Total Credits: 20**

1.6. SEMESTER: VI

Branch: Biomedical Engineering Year: *3* **Semester: VI**

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Courses			L	T	P	TA	CT	ST	ESE	TOT	
1	BM-PC-302	Tissue Engineering and Regenerative Medicine	2	1	0	15	15	30	45	75	3
2	BM-PC-304	Medical Imaging and Image Processing	3	1	0	20	20	40	60	100	4
3	BM-PC-306	Microprocessor and Microcontroller	2	1	0	15	15	30	45	75	3
Practical/Design/Laboratory/Seminar											
4	BM-PC-LC-308	Medical Imaging and Image Processing Laboratory	0	0	4	10	10	20	30	50	2
5	BM-PC-LC-310	Microprocessor and Microcontroller Laboratory	0	0	4	10	10	20	30	50	2
Program Elective/Open Elective Courses											
6	BM-OE-308E	Open Elective Courses-I	2	1	0	15	15	30	45	75	3
Internship											
7	BM-P-310	Internship	0	0	6	-	-	-	75	75	3
Total			9	4	14	85	85	170	375	500	20

Open Elective Courses-I (BM-OE-308E)		
Sl. No.	**Course Code**	**Course Title**
1.	BM-OE- 3081	Nanotechnology in Healthcare
2.	BM-OE-3082	Biological Control systems
3.	BM-OE-3083	Molecular Diagnostics and Therapeutics
4.	BM-OE-308E*	MOOCS courses as per NEHU regulations

*E: varies from 1-9; 1-3: subjects offered by department, 4-9: MOOCs courses. A student may undertake MOOCs courses approved by the department following the provision laid down in RC-20.

Internship: Students shall pursue 4-6 weeks of internship (in-house or outside the university) during winter vacation after completing the 5th-semester examination. Evaluation will be done as per RC 20.

L-Lecture	T-Tutorial	P-Practical	TA-Assessment by Teachers
CT-Class Test	ST-Sub -Total	ESE-End Semester Evaluation	TOT-Total
Contact Hours: 27		**Total Marks: 500**	**Total Credits: 20**

The entry and exit after third year will be as per RC -20.

1.7. SEMESTER: VII

Branch: Biomedical Engineering Year: 4 Semester: VII

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Courses			L	T	P	TA	CT	ST	ESE	TOT	
1	BM-PC-401	Entrepreneurship & IPR	3	1	0	20	20	40	60	100	4
2	BM-PE-403E	Program Elective-II	3	1	0	20	20	40	60	100	4
3	BM-PE-405E	Program Elective-III	3	1	0	20	20	40	60	100	4
4	BM-OE-407E	Open Elective Courses-II	2	1	0	15	15	30	45	75	3
Practical/Design/Laboratory/Seminar/Minor Project											
5	BM-P-409	Minor Project	0	0	10	25	25	50	75	125	5
Total			11	4	10	95	95	190	285	500	20

Program Elective-II (BM-PE-403E)		
Sl. No.	**Course Code**	**Course Title**
1.	BM-PE-4031	Sports Biomechanics and Rehabilitation
2.	BM-PE-4032	Robotics for Healthcare
3.	BM-PE-4033	Bio-MEMS
4.	BM-PE-403E*	MOOCS courses as per NEHU regulations

Program Elective-III (BM-PE-405E)		
Sl. No.	**Course Code**	**Course Title**
1.	BM-PE-4051	Hospital Administration and Management
2.	BM-PE-4052	Biomimetic Technology
3.	BM-PE-4053	Healthcare informatics and Telemedicine
4.	BM-PE-405E*	MOOCS courses as per NEHU regulations

Open Elective Courses-II (BM-OE-407E)		
Sl. No.	**Course Code**	**Course Title**
1.	BM-OE-4071	Medical Device Standards and Regulations
2.	BM-OE-4072	Microfluidics
3.	BM -PE-3073	Optics in Medicine
4.	BM-OE-407E*	MOOCS courses as per NEHU regulations

L-Lecture	T-Tutorial	P-Practical	TA-Assessment by Teachers
CT-Class Test	ST-Sub -Total	ESE-End Semester Evaluation	TOT-Total
Contact Hours: 25		**Total Marks: 500**	**Total Credits: 20**

*E: varies from 1-9; 1-3: subjects offered by department, 4-9: MOOCs courses. A student may undertake MOOCs courses approved by the department following the provision laid down in RC-20.

Minor Project: The evaluation of the Major project would be done as per RC 20.

1.8. SEMESTER: VIII

Branch: Biomedical Engineering Year: 4 Semester: VIII

S. No.	Course Code	Course Name	Periods (Contact Hours)			Evaluation Scheme (Distribution of Marks)					Credits
Theory Courses			L	T	P	TA	CT	ST	ESE	TOT	
1	BM-OE-402E	Open Elective Courses-III	2	1	0	15	15	30	45	75	3
Practical/Design/Laboratory/Seminar/Major Project/Viva											
2	BM-P3-404	Major Project	0	0	28	140	-	-	210	350	14
3	BM-P4-406	Grand Viva	0	0	0	-	-	-	75	75	3
Total			2	1	28	155	15	30	330	500	20

Open Elective Courses-III (BM--OE- 402E)		
Sl. No.	**Course Code**	**Course Title**
1.	BM-OE-4021	Research methodology and Technical Writing
2.	BM-OE-4022	Data Analytics in Healthcare
3.	BM-OE-402E*	MOOCS courses as per NEHU regulations

*E: varies from 1-9; 1-2: subjects offered by department, 3-9: MOOCs courses. A student may undertake MOOCs courses approved by the department following the provision laid down in RC-20.

L-Lecture	T-Tutorial	P-Practical	TA-Assessment by Teachers
CT-Class Test	ST-Sub -Total	ESE-End Semester Evaluation	TOT-Total
Contact Hours: 31		**Total Marks: 500**	**Total Credits: 20**

2. B.Tech. (BME) Detailed Course Content

2.1. First Semester Courses

2.1.1. BM-HSM-101 UNIVERSAL HUMAN VALUES-II 3-0-0=3

Subject Code: BM-HSM-101
Subject Name: *Universal Human Values-II*
No. of Hours Per Week: *Lectures-3, Tutorial-0*
Marks Distribution: *Sessional Works = 30, End Semester Examination = 45.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks.)*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and half hours.*

Course Objectives:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS', to ensure sustained happiness and prosperity, which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior, and mutually enriching interaction with Nature.

Course/Learning Outcomes: At the end of this course, students shall be able to:

1. Understand and analyze the essentials of human values and skills, self-exploration, happiness and prosperity.
2. Evaluate coexistence of the "I" with the body and evaluate the role of harmony in family, society and universal order.
3. Develop appropriate technologies and management patterns to create harmony in professional and personal lives.

Unit I: Introduction to Value Education: Right Understanding to Relationship and Physical Facility, Value Education, Self-exploration, Continuous Happiness and Prosperity, Exploring Human Consciousness. Harmony in the Human Being: Co-existence, needs and Harmony in self and Body.

Unit II: Harmony in the Family and Society: Justice in Human-to-Human Relationship, Vision for the Universal Human Order. Harmony in the Nature/Existence: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Co-existence at All Levels, Holistic Perception of Existence

Unit III: Implications of the Holistic Understanding: Natural Acceptance, Human Conduct, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, *Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019.

2. RR Gaur, R Asthana, G P Bagaria, *The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics,* 2nd Revised Edition, Excel Books, New Delhi, 2019.

3. Premvir Kapoor, *Professional Ethics and Human Value*s, Khanna Book Publishing Company, New Delhi, 2022.

Reference Books:

1. A Nagaraj, *JeevanVidya: EkParichaya*, Jeevan Vidya Prakashan, Amarkantak, 1999.

2. A.N. Tripathi, *Human Values*, New Age Intl. Publishers, New Delhi, 2004.

2.1.2. BM-BS-103 ENGINEERING MATHEMATICS 3-1-0=4

Subject Code: BM-BS-103
Subject Name: *Engineering* Mathematics
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Apply principles of calculus, complex analysis, and linear algebra to solve mathematical problems and demonstrating proficiency in differential and integral calculus techniques, complex number operations, and linear algebra concepts.
2.Utilize understanding of complex numbers, including their algebraic and geometric properties, complex plane representation, and analytic functions, to evaluate contour integrals
3. Utilize linear algebra concepts to analyze vector spaces, matrices, and linear transformations, including understanding subspaces, bases, dimensions, systems of linear equations, eigenvalues, eigenvectors, and diagonalization techniques.

Course Outcomes

1. Students will learn the principles of calculus, complex analysis, and linear algebra to solve mathematical problems and demonstrating proficiency in differential and integral calculus techniques, complex number operations, and linear algebra concepts.
2. Students will understand complex numbers, including their algebraic and geometric properties, complex plane representation, and analytic functions, to evaluate contour integrals
3. Students will uutilize linear algebra concepts to analyze vector spaces, matrices, and linear transformations, including understanding subspaces, bases, dimensions, systems of linear equations, eigenvalues, eigenvectors, and diagonalization techniques.

UNIT I
Differential Calculus of Single Variable: Functions, continuity and differentiability *(with emphasis on hyperbolic and inverse hyperbolic functions)*, Properties of continuous functions on closed intervals, Intermediate value theorem and its applications, Successive differentiation; Taylor's and Maclaurin's series; L'Hospital rule (statements only with applications)

UNIT II
Complex analysis*:* Analytic functions, Cauchy-Riemann equations, Cauchy's integral theorem, Cauchy's integral formula, Taylor series and Laurent series. Residues and their applications to evaluating real integrals (statements only with applications).

UNIT III
Laplace and Fourier Transforms: Laplace transforms, existing theorem, Inverse transform., Shifting on the *s* and *t* axes, Laplace transform of derivatives, convolutions, partial fractions, Fourier transforms, Solutions of ordinary differential equations by Laplace transforms.

UNIT IV
Linear Algebra: Vector space over the field of real and complex numbers, subspaces, bases and dimension; Elementary row and column operations; echelon form; system of linear equations; Eigen values and eigen vectors; Symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal matrices.

Text Books

1. E. Kreyszig, “Advanced Engineering Mathematics”, Tenth Ed, John Wiley & Sons Inc., 2017.
2. S. Pal and S. C. Bhunia, “Engineering Mathematics’ , Oxford University Press, 2015.
3. R. K. Jain and S. R. K. Iyengar, “Advanced Engineering Mathematics”, Narosa Publishing House, 5th edition, 2016.

Reference Books

1. Babu Ram, “Engineering Mathematics”, Pearson.2009.
2. Sastry, “Engineering Mathematics”, PHI. 2009.
3. M. C. Potter, J. L Goldberg and E.F. Aboufadel, “Advance Engineering Mathematics” (Third Edition),Oxford University Press 2005.

2.1.3.BM-ES-105 PROGRAMMING FOR PROBLEM SOLVING 3-1-0=4

Subject Code: BM-ES-105
Subject Name: Programming for Problem Solving
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Develop a comprehensive understanding of fundamental programming concepts such as variables, data types, control structures, functions, and algorithms.
2. Learn the syntax and semantics of programming languages commonly used for problem solving.
3. Gain proficiency in translating problem statements into structured algorithms and implementing them using programming constructs.

Course Outcomes

1. Upon completion of the course, students will demonstrate proficiency in programming concepts, including variables, data types, control structures, functions, and algorithms.
2. Through hands-on coding exercises, assignments, and projects, students will gain practical experience in translating problem statements into executable code using Cprogramming language and methodologies.
3. Upon completing the course, students will be able to apply their C programming skills to solve real-world problems in various domains, including science, engineering, business, and technology.

UNIT - I
Digital computer fundamentals: Functional components of computer, Von Newman Architecture, Algorithm and flowcharts, Data representation, Programming languages, Function of system software.

UNIT - II
Imperative programming (Using C): Overview of C, Constants, Variables and Data Types, Operators and Expressions, Input and Output Operations, Branching and looping operation.

UNIT - III
Functions: Defining a function, accessing a function, passing arguments to a function, Specifying argument data types, function prototypes and recursion, storage classes. Arrays: Defining an array, processing an array, passing arrays to a function, multidimensional arrays, strings, string handling functions.

UNIT - IV
Structures and Unions: Defining and processing of structure and union, Array of structure, array within structure, passing of structure as argument. Pointers: Fundamentals, pointer declarations, passing pointers to a function, pointer and one dimensional arrays, pointer as function arguments, Functions returning Pointer, Pointer to functions, pointers and structures. File Management: Introduction, Defining and Opening a File, Closing a File, Input/output Operations on Files, Error Handling during I/O Operations, Random Access to Files, command line Arguments.

Text Books

1. V. Rajraman, Fundamental of Computer, 4/e, PHI, 2006.

2. E. Balaguruswami, Programming in ANSI C, 2/e, Tata McGraw Hill, 2004.

Reference Books

1. Y. Kanetkar, Let us C, BPB Publication, 2004.

2. B. W. Kernighan and D. Ritchie, The C Programming Language, 2/e, PHI, 2005.

2.1.4. BM-PC-107 HUMAN ANATOMY AND PHYSIOLOGY 3-1-0=4

Subject Code: **BM-PC-107**
Subject Name: *Human Anatomy and Physiology*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. To understand the anatomy and physiology of human body
2. To understand the concepts of engineering principles involved in the anatomy and physiology of human body

Course Outcomes

1. Understand the anatomy and physiology of human body
2. Understand the various physiological processes that maintain homeostasis of human body system.
3. Correlate the anatomy and physiology of the human system with various topics of biomedical engineering.

UNIT-I
Introduction to the Human Body: Structure and function of Cell & cellular components, Blood and its composition, Innate and acquired Immune system, Human body planes and sections.

UNIT-II
Cardiovascular, Respiratory and Gastrointestinal System: Heart, Conductive tissue of heart, Cardiac cycle, Heart valves, Systemic & pulmonary circulation, Transmission of cardiac impulse, Blood pressure. Respiratory system: Respiration external (ventilation), Exchange in gases in the alveoli, Artificial respiration. All organs of the digestive system, their secretions & main functions.

UNIT-III
Nervous System and Musculoskeletal System: Structure, Biology of neuron, Synapses and action potential generation, Mirror neurons, functioning, Reflex action & reflex arc. Function of sympathetic nervous system, Nervous conduction & action potentials. Sense organs: Eye, Ear, Integumentary system: Structure, Type and functions of skin. Structure and function of skeletal, smooth and cardiac muscle

UNIT-IV
Genitourinary and Endocrine Systems: Excretory system: Structure of Nephron, Formation of urine & function of kidneys, Urinary bladder, urethra, Internal/external sphincters. Endocrine glands, their secretions, Control of secretions. Reproductive system of male and female, Spermatogenesis and oogenesis.

Text Books
1.David Shier, Jackie Butler, Ricki Lewis, *Hole's Human Anatomy & Physiology*, Mc-Graw Hill India , 13th Edition,2016.
2.Kim E. Barrett, Susan M. Barman , Scott Boitano, Heddwen Brooks, *Ganong's Review of Medical Physiology*, McGraw-Hill Education , 25th edition, 2015.

Reference Books

1. K. Saladin, *Anatomy & Physiology: The Unity of Form and Function*, McGraw-Hill College, 7th edition, 2014.

2. R. Drake, A. W. Vogl, Adam W. M. Mitchell, and R. Tibbitts, *Gray's Atlas of Anatomy*, Churchill Livingston , 2nd edition, 2014.

2.1.5. BM-ES-LC-109 COMPUTER PROGRAMMING LABORATORY 0-0-4=2

Subject Code: *BM-ES-LC-109*
Subject Name: *Computer Programming Laboratory*
No. of Hours Per Week: *Practicals-4*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten*
Questions to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours.*

Course objectives

1. Utilize programming languages and tools to implement solutions for practical problems encountered in diverse domains.
2. Gain hands-on experience in translating problem statements into executable code, applying programming constructs such as variables, loops, and functions.
3. Develop proficiency in debugging and troubleshooting code to identify and resolve errors, enhancing problem-solving skills in a practical context.

Course outcomes

1. Upon completion of the laboratory sessions, students will demonstrate the ability to apply programming concepts and techniques to solve practical problems effectively.
2. They will be able to develop, debug, and optimize code using programming languages and tools, translating problem statements into executable solutions.
3. Through hands-on coding exercises and projects, students will gain practical experience in implementing algorithms, data structures, and computational techniques to address diverse problem domains.

List of Experiments

1. Operators and Expressions: At least three C programs using operators and expressions.
2. Branching: At least five C programs using if, switch-case construct of C.
3. Looping: At least three C programs (each), incorporating for loop, while loop and do-while loop.
4. Array: At least three C programs using array (1D and 2D)
5. String: string manipulation and use of standard library functions in C.
6. Function: At least three C programs using function, Demonstration call-by value and call-by-address, passing array (1D and 2D) to a function, at least two C programs related to recursive function.
7. Pointer: At least three C programs using pointer, function and array.
8. Structure & Union: At least one C program using structure, demonstration of difference between structure and union.
9. File handling and Commands line arguments: C programs involving opening, closing, reading/writing a file.
10. Copy the content of one file to another file using commands line, arguments.

Text Books

1. B. S. Gotfried, Programming in C, Schuam Outline Series, TMH, 2005.
2. R. Kumar and S. Jain, *Programming Laboratory: Hands-On Approach*, New Delhi: Tech Books India, 2018.

Reference books

1. A. Singh and P. Patel, *Fundamentals of Computer Programming Laboratory*, Mumbai: EduPub India, 2020.
2. R. Sharma and S. Gupta, *Computer Programming Laboratory: Concepts and Practices*, New Delhi: TechBooks India, 2019.

2.1.6. BM-PC-LC-111 MEDICAL TECHNOLOGY LABORATORY 0-0-4=2

Subject Code: *BM-PC-LC-111*
Subject Name: *Medical Technology Laboratory*
No. of Hours Per Week: *Practicals-4*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten*
Questions to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Provide students with an introduction to the fundamental principles and concepts of biomedical instrumentation, different physiological parameter detection methods, anatomical structural studies.

2. Familiarize students with a variety of biomedical devices and instruments commonly used in clinical settings, research laboratories, and healthcare facilities.

3. Develop a basic understanding of the operation, calibration, and maintenance of biomedical instruments, including physiological monitors, medical imaging systems, and diagnostic devices, medical simulation.

Course Outcomes

1. Upon completion of the laboratory sessions, students will have acquired hands-on experience with a variety of biomedical instruments and devices commonly used in healthcare settings. The student will gain primary knowledge on method for detection of various human physiological parameters.

2. They will demonstrate proficiency in operating, calibrating, and troubleshooting biomedical instrumentation, including physiological monitors, medical imaging systems, and diagnostic devices.

3. Through practical exercises and experiments, students will gain practical skills in acquiring, processing, and analyzing biomedical signals and data, preparing them for roles in biomedical engineering research and industry.

List of Experiments

1. Tostudy the transvers section of various glands (PancreasGland, LiverGland, ThyroidGland, AdrenalGland, T.S. of Spinal cord).
2. To determine Human Blood Group.
3. To study the clotting time and bleeding time.
4. To study estimation of erythrocyte sedimentation rate(ESR).
5. Estimation of hemoglobin percentage by haemometer.
6. To determine the total no.of RBCs and WBCs in Human blood.
7. To study human hearing loss using Audiometer.
8. To study physiology of heart using ECG.
9. To study physiology of muscles using EMG.
10. To study various physiological parameter using simulation model.
11. To study the various medical image modalities(X-Ray, CT, MRI etc.)for diseases diagnosis.
12. To study various tissue using animal model.

Text Books

1. R. L. Magjarevic and M. H. M. A. Hamza, Eds., "Biomedical Engineering: Concepts, Methodologies, Tools, and Applications," 1st ed. Hershey, PA, USA: IGI Global, 2011.

2. S. Rattan and A. Goel, "Biomedical Instrumentation and Measurements," 2nd ed. New Delhi, India: Prentice-Hall of India, 2012.

Reference Books

1. J. G. Webster, Ed., "Medical Instrumentation: Application and Design," 4th ed. Hoboken, NJ, USA: Wiley, 2009.

2. J. D. Enderle, S. M. Blanchard, and J. Bronzino, "Introduction to Biomedical Engineering," 3rd ed. Oxford, UK: Academic Press, 2012.

2.1.7. BM-PC-LC-113 BIOMEDICAL ENGINEERING WORKSHOP 0-0-2=1

Subject Code: *BM-PC-LC-113*
Subject Name: *Biomedical Engineering Workshop*
No. of Hours Per Week: *Practicals-2*
Marks Distribution: *Sessional Works = 10, End Semester Examination = 15.*
Minimum number of Experiments to be carried out: *Ten*
Questions to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Two Hours.*

Course Objectives

1. To familiarize biomedical engineering students with fundamental principles and techniques across multiple engineering disciplines. To learn various laboratory safety measurement.
2. To develop students practical skills in designing, prototyping, and testing for engineering solutions for biomedical applications.
3. To cultivate interdisciplinary collaboration and problem-solving abilities among biomedical engineering students through project-based learning activities.

Course Outcomes

Upon completion of this course, the students will gain knowledge of the differentmanufacturing processes which are commonly employed in the industry, to fabricate components using different materials. Students will collaborate effectively in interdisciplinary teams to develop and present engineering projects addressing real-world biomedical challenges.

List of experiment

1. Study working principle of machine tools -Lathe machine
2. Use of hand tools in fitting, preparing a male and female joint of M.S. or making a paper weight of M.S.
3. To study principle of welding practice: Gas Welding& Electric Arc welding Practice.
4. To make different joints -Lap joint, a T-joint or a Butt joint is to be prepared or to make furniture.
5. To develop basic 3D geometry using CAD modelling.
6. To assemble FDM 3D printers.
7. To explore principles of biomechanics through hands-on activities such as testing the mechanical properties of biomaterials, measuring forces exerted by muscles.
8. To design and prototype medical devices, from needs assessment and concept development to CAD modelling and fabrication using 3D printers.
9. To study basic tools and equipment commonly used in biomedical engineering workshops, such as soldering irons, multi-meters, oscilloscopes, and hand tools.
10. To study the various laboratory/ workshop related safety measures, Electrical Safety, Introduction about Factory Act, 1948, BOCW Act, Electrical Acts and Rules.

Textbooks

1. M. F. Ashby and K. M. Shercliff, "Materials: Engineering, Science, Processing and Design," 3rd ed. Boston, MA, USA: Butterworth-Heinemann, 2020.

2. C. J. Date, "An Introduction to Database Systems," 8th ed. Boston, MA, USA: Pearson/Addison Wesley, 2004.
3. John K.C., Mechanical Workshop Practice. 2nd Edn. PHI 2010.
4. JeyapoovanT.and Pranitha S., Engineering Practices Lab Manual, 3rd Edn. Vikas Pub.2008.

Reference Books:

1. D. M. Pozar, "Microwave Engineering," 4th ed. Hoboken, NJ, USA: Wiley, 2012.
2. J. C. Martin, "Digital Integrated Circuit Design," New York, NY, USA: Oxford University Press, 2015.

2.1.8. BM-AU-115 IDEA WORKSHOP 0-0-4=0

Subject Code: BM-AU-115
Subject Name: Idea Development, Evaluation and Application (IDEA) Workshop
No. of Hours Per Week: Lectures-2
Marks distribution: Continuous Assessment: 50

Course Objectives

1. To foster creativity, innovation, and design thinking skills among biomedical engineering students.
2. To provide students with practical experience in identifying unmet needs in healthcare and developing innovative solutions.
3. To cultivate entrepreneurial mindset and skills necessary for translating engineering ideas into viable products and services.

Course Outcomes:

1. Students will demonstrate proficiency in applying design thinking methodologies to identify and analyze healthcare challenges and develop innovative solutions.
2. Students will gain hands-on experience in prototyping, testing, and iterating engineering solutions in a collaborative workshop environment.
3. Students will develop entrepreneurial skills such as market research, business model development, and pitching, enabling them to commercialize their engineering innovations effectively.

Workshops

1. Introduction to Design and Innovation

2. Creativity techniques and ideation methods

3. Case studies of innovative biomedical engineering solutions

4. Identifying Healthcare Needs and Opportunities

5. Idea Generation and Concept Development

6. Market analysis and opportunity assessment

7. Pitch development and storytelling

8. Presentation of final projects to stakeholders and potential investors

9. Regulatory policy for Biomedical Devices

10. Field visit to hospital or Biomedical industry.

Experts from Industry and academia may be called for conducting the workshop. Students will be asked to present new ideas and realize the unmet needs of the healthcare sector.

Textbooks

1. T. Kelley and J. Littman, "The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm," 1st ed. New York, NY, USA: Currency Doubleday, 2001.

2. D. Blank and S. Dorf, "The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company," 1st ed. Pescadero, CA, USA: K&S Ranch, 2012.

Reference Books

1. T. Brown and B. Katz, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation," 1st ed. New York, NY, USA: HarperBusiness, 2009.
2. A. Osterwalder and Y. Pigneur, "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers," 1st ed. Hoboken, NJ, USA: Wiley, 2010.

2.2. Second Semester Courses

2.2.1. BM-HSM-102 PROFESSIONAL COMMUNICATION SKILLS 3-0-0=3

***Subject code**: BM-HSM-102*
***Subject Name**: Professional Communication Skills*
***No. of Hours per week:** Lectures 3, Tutorial-0.*
***Marks Distribution**: Sessional Works = 30, End Semester Examination = 45.*
***Questions to be set**:* Eight *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
***Questions to be answered**:* Five
***Duration of End Semester Examination**:* Two and half Hours.

Course Objectives

1. Developing Effective Written Communication Skills: To equip students with the knowledge and skills necessary to communicate effectively through various written formats commonly used in the biomedical field, including technical reports, research papers, and professional emails.
2. Enhancing Oral Presentation Skills: To cultivate students' ability to deliver clear, organized, and engaging oral presentations on technical topics related to biomedical engineering, including project proposals, research findings, and technical reports.
3. Fostering Interpersonal Communication Skills: To facilitate the development of interpersonal communication skills essential for collaboration, teamwork, and professional interactions in the biomedical workplace, including active listening, conflict resolution, and negotiation.

Course Outcomes

1. Proficiency in Written Communication: Upon completion of the course, students will demonstrate proficiency in written communication by producing well-organized, coherent, and concise technical documents relevant to biomedical engineering, such as project proposals, research reports, and professional correspondence.
2. Effective Oral Presentation Skills: Students will develop effective oral presentation skills, including clear articulation, appropriate use of visual aids, and confident delivery, enabling them to effectively communicate technical concepts and findings to diverse audiences in the biomedical field.
3. Strong Interpersonal Communication Skills: By engaging in interactive exercises, role-plays, and group discussions, students will enhance their interpersonal communication skills, including active listening, empathy, and professionalism, fostering effective collaboration and teamwork in biomedical engineering projects and workplaces.

UNIT-I

General Principles of Communication and Oral Communication: The process of Communication, principles of Communication (Communication barriers, levels of Communication, communication network, verbal, non-verbal) and professional Communication. The Speech Mechanism, IPA Symbols (Vowels and consonant sound),minimal pairs, word transcription, stress and intonation, active listening, types of listening, traits of a good listener, active versus passive listening.

UNIT-II

Constituents of Effective Writing and Vocabulary: The sentence and its parts, articles, the verb phrase, tense and aspect, the active and passive, the adjective, interrogative and negative sentences, concord, preposition. Paragraph development, summary writing and reading, comprehension word formation processes: affixation, compounding, converting, use of words in different parts of speech, idioms and phrases.

UNIT-III

Business Correspondence and Communication Strategies: Characteristics of business Letter, Drafting: Bio-data/ Resume/Curriculum Vitae (Theory) .Type of Reports (Theory) Presentation skills, public speaking and grouping discussion (Theory) and Soft Skills (theory).

Text Books

1. B.K Das, K. Samantray," An Introduction to professional English and Soft Skills", CUP, New Delhi, 2009.
2. R.C. Sharma and K. Mohan, "Business correspondence and Report Writing", Tata McGraw Hill, New Delhi, 2002.
3. Doff, C. Jones, "Language in Use, Upper-Intermediate Classroom Book", CUP, New Delhi, 2004.

Reference Books

1. O' Connor, "Better English Pronunciation", CUP, London, 2006.
2. P. Patnaik, P., "Group Discussion and Interview Skills", CUP, New Delhi, 2011.

2.2.2. BM-BS- 104 ENGINEERING PHYSICS 3-0-0=3

Subject Code: BM-BS-104
Subject Name: Engineering Physics
No. of Hours Per Week: *Lectures 3*
Mark distribution: *Internal Assessment = 30, End semester examination = 45*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Number of questions to be answered*: Any five*
Duration of the end semester examination*: Two and half-hour*
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Course Objectives

1. Understand the fundamental principles underlying oscillatory motion, including simple harmonic motion (SHM), damped oscillation, and forced oscillation, Understanding the propagation of vibration as wave in various mediums such as strings and optical systems, and the generation and application of ultrasonic waves in engineering and technology.

2. Gain insight into optical phenomena such as interference, diffraction, and polarization, and their significance in various scientific and technological applications.

3. Understanding the role and connection of physics with engineering, technological revolution leading to various industrial revolutions at different decades and centuries.

Course Outcomes

1. Ability to analyze and solve problems related to oscillatory systems, including damped oscillators, forced oscillators. Ability to apply wave equations to predict wave motion in different mediums, including strings and optical systems.

2. Competence in interpreting optical phenomena such as interference, diffraction, and polarization, and their applications in optical instruments like polarimeters, spectrometers, opto-electronic instruments.

3. Ability to understand the definite connection of physics and different industrial revolutions in the past and also able to understand the upcoming deep-tech industrial revolution in the future based on science and technology.

UNIT-I
Vibration and Waves: Simple harmonic motion (SHM). Superposition of SHMs. Lissajous' figures, Damped oscillator, Forced oscillator, Wave equation and solution, Wave and particle velocity. Wave equation in string, Production, properties and application of ultrasonic waves.

UNIT-2
Optics: Fermat's principle of least time. Interference. Newton's rings experiment. Fresnel and Fraunhofer diffractions. Diffraction grating. Polarization of light. Nicol prism, Optical activity, Polarimeter.

UNIT-3
Physics-Engineering Interface (Qualitative): Role of physics in industrial revolution, Thermodynamic Rankine cycle, Otto cycle, steam engine, steam turbine, and Internal Combustion (IC) engine, Newton's gravitational law and Satellite; Faraday Law and electric motor and transformer; Total Internal reflection and fiber optical cable; Magnetic hysteresis and memory device; Nuclear fission and Nuclear power, Nuclear reactor and Nuclear Bomb; Semiconductor P-N junction and transistor, solar cell; Quantum confinement of an electron in potential

box and Nanotechnology; Molecule rotational spectroscopy and microwave oven, Capacitor, and Supercapacitor Energy Storage; Quantum superposition and quantum technology.

Text Books:

1. Engineering Physics: Hitendra K Malik and A K Singh, Tata McGraw Hill Education Private Limited, New Delhi, 1st edition (2011)

2. Engineering Physics: Rakesh Dogra, S K Kataria& Sons, 1st edition (2019)

3. The Physics of vibrations and waves: H J Pain, John Wiley & Sons Inc, 6th edition (2005)

Reference Books

1. Elementary Wave Optics: Robert H Webb, Dover Publication Inc, 2005th edition (2005)

2. Reconceptualizing the Industrial Revolution, Horn, Jeff; Rosenband, Leonard; Smith, Merritt (2010). Cambridge MA, London: MIT Press. ISBN978-0-262-51562-7.

2.2.3. BM-ES- 106 BASIC ELECTRICAL ENGINEERING 3-0-0=3

Subject Code: BM-ES-106
Subject Name: Basic Electrical Engineering
No. of Hours Per Week: *Lectures-3, Tutorial-0*
Mark distribution: *Internal Assessment = 30, End semester examination = 45*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of the end semester examination*: Two and half-hour*

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Course Objectives

1. To present a problem-oriented introductory knowledge of electrical circuits.

2. To earn knowledge about different electrical circuit

Course Outcomes

1. The student can acquire the basic knowledge of electrical components

2. The students also acquired knowledge about electric circuit and their application

UNIT – I
Engineering Circuit Analysis: Circuit elements, Ohm's law, Kirchoff's law, Nodal Analysis, Mesh Analysis, and Source transformations. Linearity and Superposition, Thevenin and Norton Theorems, Maximum power transfer theorem, Star-Delta and Delta-Star Conversion.

UNIT – II
Series and Parallel RLC Circuits: Simple RL and RC Circuits, Phasor Concept, Impedance and Admittance, Phasor diagrams, Response as a Function of, Instantaneous Power, Average Power, RMS values of Current and Voltage, Apparent Power and Power Factor, Complex Power, Introduction to Three Phase Circuits.

UNIT – III
DC Machines: Principle of DC Generator, Methods of excitation, Characteristics and Applications, Principle of DC Motor, Types, Speed – Torque Characteristic, Speed Control Transformers: Working principle of Transformers, Equivalent Circuit, Transformer tests, Bode Plot. Three Phase: Induction Motor: Construction, Production of rotating field, Slip, Torque andSlip. Single Phase Induction Motor: Double field-revolving theory, Shaded Pole single phaseinduction motor. Stepper Motors.

Text Books

1. B. L. Therasa, Basic Electrical Engineering, S. Chand and sons, 2006
2. T. L. Skvarenina, "Electrical Engineering: Concepts and Applications," Boca Raton, FL, USA: CRC Press, 2016.
3. S. A. Nasar, "Electric Circuits," 3rd ed. New York, NY, USA: McGraw-Hill, 2001.

Reference Books

1. C. L. Wadhwa, "Electrical Power Systems," 6th ed. New Delhi, India: New Age International, 2016.
2. A. E. Fitzgerald, C. Kingsley, Jr., and S. D. Umans, "Electric Machinery," 6th ed. New York, NY, USA: McGraw-Hill Education, 2003.

2.2.4. BM-PC-108 BIOCHEMISTRY AND MICROBIOLOGY 3-1-0=4

Subject Code: BM-PC-108
Subject Name: *Biochemistry and Microbiology*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Foster an appreciation for the interdisciplinary nature of biochemistry and microbiology and their relevance to various fields, including medicine, agriculture, biotechnology, and environmental science.
2. Cultivate critical thinking and analytical skills necessary for interpreting experimental data, analyzing scientific literature, and solving problems in biochemistry and microbiology.
3. Introduce students to the biochemical structure, function, and metabolism of biomolecules such as proteins, carbohydrates, lipids, and nucleic acids.

Course Outcomes

1. Upon completion of the course, students will demonstrate a comprehensive understanding of fundamental concepts in biochemistry and microbiology.

2. They will be able to explain the structure, function, and metabolism of biomolecules, as well as the diversity, classification, and characteristics of microorganisms.

3. Through theoretical lectures, readings, and discussions, students will develop a solid foundation in biochemical and microbiological principles, providing a basis for further study and professional practice in related fields.

UNIT-I

Introduction to Biochemistry and Medicine: Proteins, Enzymes: General properties of enzymes, Spectrophotometric measurement of enzymes (proteins) isolation methods study of enzyme properties, Diagnostic enzymes, Urine biochemistry. Biosensor development and its applications.

UNIT-II

Instrumentation: Principles and applications of Differential Centrifugation, Photometry, spectrophotometry, Fluorometry, Nephalometry and turbidimetry, and Biochemical analysis carried out in the estimation of blood constituents like glucose, Urea, Creatinine, Protein, Cholesterol, Bilirubin, etc., Electrophoresis.

UNIT-III

Metabolism: Catabolic and anabolic pathways for biomolecules. Isotopes and its application in life sciences and medicine. Basic of Microbiology: Introduction, Types of microbes, Structure of Bacteria, Fungi, Virus.

UNIT-IV

Microbial isolation and Infections: Infection due to microbes, Sterilization process. Hospital-acquired infections and their measurement. Methods of microbial isolation, secondary metabolite production by microbes and their medical applications.

Text Books

1. Jagmohan, “Organic Spectroscopy-Principles and applications”, 2nd Edition, Narosa Publishing House, 2004.
2. A.V.S.S. Rama Rao, “A textbook of biochemistry”, Ubs Publishers' Distributors Ltd, 2008.

3. Trenor Palmer, "Enzymes-Biochemistry, Biotechnology, Clinical chemistry", 2nd Edition, EWP, 2007.

Reference Books

1. Jagmohan, "Organic analytical chemistry-Theory and Practice", 25th Edition, McGraw Hill, 2010.
2. J.L. Jain, Sanjay Jain, "Fundamentals of biochemistry", 1st Edition, S.Chand Publication, 2007.
2. J.L. Jain, Sanjay Jain, "Fundamentals of biochemistry", 1st Edition, S.Chand Publication, 2007.

2.2.5. BM-BS-LC-110 ENGINEERING PHYSICS LABORATORY 0-0-4=2

Subject Code: BM-BS-LC-110
Subject Name: *Engineering Physics Laboratory*
No. of Hours Per Week: *Practical-4*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Questions to be set: *Ten*
Questions to be answered: *One question will be allotted based on lottery*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. To provide hands-on experience and reinforce theoretical concepts learned in engineering physics through a series of experiments covering various topics such as mechanics, optics, and modern physics.
2. To develop practical skills including experimental setup, data acquisition, analysis, and interpretation, as well as proficiency in using laboratory equipment and instruments relevant to engineering physics.

Course Outcomes

1.Ability to perform and analyze experiments related to fundamental concepts in engineering physics, such as determining physical constants, measuring wavelengths of light, studying magnetic properties, and investigating electrical circuits, leading to a deeper understanding of the underlying principles.
2. Proficiency in experimental techniques and methodologies, including calibration procedures, statistical analysis, and error estimation, developing critical thinking, problem-solving skills, and the ability to apply scientific methods in laboratory settings, thereby preparing students for practical applications in engineering and scientific research.

List of Experiments:
1. To determine the acceleration due to gravity by bar pendulum/Kater's pendulum.
2. To determine rigidity modulus of a wire by statistical method/dynamical method.
3. To find the wavelength of monochromatic light by using Newton's ring method.
4. To determine the wavelength of sodium light by Michelson's interferometer.
5. To determine the wavelength of prominent lines of mercury by plane diffraction grating.
6. To determine he specific rotation of sugar solution by polarimeter.
7. To determine the magnetic moment of a bar magnet (M) and the earth's horizontal intensity (H) (by deflection and vibration magnetometers).
8. To determine the resistance per unit length of a meter bridge wire by Carey- Foster Method.
9. Calibration of Ammeter and Voltmeter using potentiometer.
10. To study decay of current in RC circuit.
11. To study Lissajous figure using CRO
12. To determine frequency of a tuning fork by Melde's method.
13. To determine ultrasonic velocity in liquid.
14. To obtain the hysteresis curves (B-H) for a ferromagnetic material (thin rod or wire) on a CRO using solenoid and then to determine the related magnetic constants.
15. To study the Hall Effect and determine the Hall Coefficient.
16. To determine the Planck's constant by a Photocell.
17. To determine the e/m value of an electron by any method.

Text Books

1. Samir Kumar Ghosh, “A Text book of Practical Physics”, New Central Book Agency, Kolkata, 2006.
2. Gupta and Kumar, “Practical Physics”, PragatiPrakashan, Meerut, U.P., 2005.
3. C. L. Arora, “Advance B.Sc. Practical Physics”, S. Chand, 2004.

Reference Books

1. H J Pain, “The Physics of Vibrations and Waves”, 6th Ed., Wiley Student Edition, 2005.
2. P V Naik, “Principles of Physics”, Prentice Hall of India Pvt. Ltd., 2000.

2.2.6. BM-ES-LC-112 BASIC ELECTRICAL ENGINEERING LABORATORY

0-0-4=2

Subject Code: *BM-ES-LC-112*
Subject Name: *Basic Electrical Engineering Laboratory*
No. of Hours Per Week: *Practicals-4*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten.*
Question to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours.*

Course objectives

1.To equip the students with in-depth basic concepts and understanding of the principles of operation, construction and characteristics of semiconductor devices, and their utilization in basic electrical & electronics building blocks and their performances practically.
2. To learn the basic laws of electrical & electronics engineering along with practical experience with operation and applications.

Course Outcomes

1. Students can Verify Thevenin's theorem, Norton's theorem. Maximum transfer theorem (MPTT) and analyze the effects of open and short circuits in DC circuits.
2. Students can understand the comparison of power factors of different types of lamps, measurement of R & L in a choke coil (3-voltmeter-method)
3. Understand the working principles of D.C motor and D.C generator and single-phase transformer.

List of Experiments:

1. To verify Thevenin's theorem.
2. To verify Norton's theorem.
3. To verify Maximum Power Transfer theorem.
4. To verify that the phasor sum of currents at any junction in an A.C. circuit is zero.
5. To measure Power and power factor of the load by three ammeters method.
6. To measure Power and power factor of the load by three voltmeters method.
7. To perform Open circuit and Short Circuit Tests on a single phase transformer.
8. To determine the Open Circuit Characteristic of D.C. Generator
9. To measure and control the Speed of D.C. motors using Tachometer.
10. To calibrate an ammeter as voltmeter.

Text Books

1. W. H. Hayt, J. E. Kemmerly and S.M. Durbin, "Engineering Circuit Analysis", 6th Edition, TMH, 2006.
2. B. L. Thereja and A.K. Thereja, "Electrical Technology", Vol-II, S. Chand & Co., Reprint, 2006.

Reference Books

1. Van Valkenburg, "Network Analysis", 3rd Edition, PHI, 2005.
2. D. Roy Choudhury, "Networks and Systems", New Age Publishers, 1998.

2.2.7. BM-PC-LC-114 MEDICAL TECHNOLOGY LABORATORY-II 0-0-4=2

Subject Code: *BM-PC-LC-114*
Subject Name: *Medical Technology Laboratory-II*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten.*
Questions to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. To familiarize students with the basic principles and concepts of biochemistry and microbiology relevant to biomedical engineering, including cellular processes, biomolecules, metabolic pathways, and microbial characteristics.
2. To develop practical laboratory skills essential for biomedical engineering research and practice, including experimental design, sample preparation, data collection, analysis, and interpretation using biochemistry and microbiology techniques.
3. To cultivate critical thinking and problem-solving abilities among students by engaging them in hands-on laboratory experiments, troubleshooting challenges, and interpreting experimental results in the context of biomedical engineering applications.

Course Outcomes

1. Upon completion of the course, students will be able to apply a range of biochemical and microbiological techniques, such as spectrophotometry, chromatography, culturing, staining, and microscopy, to investigate biological systems relevant to biomedical engineering.
2. Students will be able to integrate theoretical knowledge of biochemistry and microbiology with practical laboratory experiences to analyze biological samples, identify biomolecules, characterize microbial cultures, and correlate experimental findings with theoretical concepts in biomedical engineering.
3. By working in teams and presenting laboratory findings in written reports and oral presentations, students will enhance their communication and collaboration skills, effectively conveying scientific ideas, experimental procedures, results, and conclusions within the context of biomedical engineering applications.

List of Experiments

1. To perform estimation of blood glucose level by enzymatic method (GOD-POD).
2. Proteins: Test for albumin and globulin, Test for Cysteine.
3. Estimation of Blood Urea.
4. Estimation of Blood Cholesterol.
5. To perform Liver function test SGOT and SGPT.
6. To perform Alkaline phosphates test.
7. To study of abnormal urine content bile pigment salt.
8. Estimation of total serum bilirubin.
9. Estimation of gastric juices – pH and acidity test.
10. To perform different types of streaking methods on different media.
11. To culture bacteria on petri plates.

12. To culture and identification of fungi on petri plates.
13. To study the structure of different types of viruses and there corresponding infections.

Text Books

1. A.V.S.S. Rama Rao, "A textbook of biochemistry", 1st Edition, Ubs Publishers' Distributors Ltd, 2008.
2. Jagmohan, "Organic Spectroscopy-Principles and Applications", 2nd Edition, Narosa Publish House, 2004.

Reference Books

1. Jagmohan, "Organic Analytical chemistry-Theory and Practice", 25th Edition, McGraw Hill, 2010.
2. J.L. Jain, Sanjay Jain, "Fundamentals of biochemistry", 1st Edition, S.Chand Publication, 2007.

2.2.8. BM-PC-LC-116 PROFESSIONAL COMMUNICATION SKILLS LABORATORY 0-0-2=1

Subject Code: BM-PC-LC-116
Subject Name: Professional Communication Skills Laboratory
No. of Hours per Week: Four hours.
Marks Distribution: Sessional Works = 10, End Semester Examination = 15
Questions to be Set: Minimum Ten.
Questions to be Answered: Any will be allotted to each student on Lottery basis.
Duration of End Semester Examination: Three Hours.

Course objectives

1. To improve the communicative competence of the students.
2. To enable the students to converse in their life situations.
3. To Train the students to use English for practices purposes.
4. To Enable the students to acquire phonetic skills required for oral skill.

Course outcome:

1. Students should be able to craft clear, concise, and professional written communication, including emails, reports, memos, and other documents relevant to their field.
2. Students should develop the ability to communicate effectively through spoken language, including clarity, tone, and delivery in presentations, meetings, and discussions.

Laboratory Practices:

Communications skills-Social:

1. Meeting people and asking questions
2. Making Friends
3. Dos and don’ts
4. What did you do

English Concept:

1. Grammer- Tenses
2. Grammer- Part of speech
3. Figure of speech
4. Direct and indirect speech

Pronunciation Phonetics- Intonations

1. Vowels
2. Consonants
3. Noun

Advanced learning and soft skills

1. Effective communication
2. Interview handling skills
3. E-mail ent iquette

Communication skills Listening- speaking- Reading

1. Listening skills
2. Speaking skills
3. Reading skills

4. Writing skills

Text Books:

1. Jones, Daniel, Cambridge English Pronouncing Dictionary with CD, New Delhi, 2011
2. Cambridge Learners Dictionary with Cd, CUP, New Delhi, 2009.

2.2.9. BM-AU-118 ENVIRONMENTAL SCIENCE 2-0-0=0

Subject Code: BM-AU-118
Subject Name: *Environmental Science*
No. of Hours Per Week: *Lectures-2*
Mark distribution: *Continuous assessment: 50*

Course Objectives:
1: To demonstrate the understanding about the environment and its components
2: To demonstrate comprehensive understanding of the causes of different environmental problems and their management.

Course Outcomes:
1: Ability to recognize the various components of the environment and how it functions.
2: Develop the ability among students to identify the causes and effect of different pollution on human health and environment

Unit I
Environment, Ecosystems and Biodiversity: Concept of environment: Scope of Environmental Science, components of environment and their interactions; abiotic and biotic factors; Ecosystems: characteristic feature and structure and function of forest, grassland, desert and aquatic ecosystem (Ponds, lakes, rivers, oceans); Ecological pyramid; energy flow and nutrient cycling; Biodiversity: value of biodiversity; loss and conservation of biodiversity.

Unit II
Environmental problems and Management: Environmental problems and issues: greenhouse effect, ozone depletion, acid rain; Environmental pollution: sources and effect of air, water, soil, radioactive and noise pollution; Industrial pollutants and their impact on environment and human health; toxic chemicals: heavy metals and pesticides; biotransformation and bioremediation; Aerobic and anaerobic treatment of waste water; waste management.

Text Books
1. W. P. Cunningham and W.B. Saigo, “Environmental Science”, McGraw Hill, New York, 1999.
2. E. P. Odum and G. W. Barrett, “Fundamentals of Ecology”, Thomson Asia Pvt. Ltd., Singapore, 2005.
3. E. Bacci, “Contaminants in the Environment”, CRC Press, 1994.

Reference Books
1. N. J. Sell, “Industrial Pollution Control: Issues and Techniques”, Wiley Publication, 1992.
2. Venugopal Rao, “Textbook of Environmental Engineering”, PHI, 2003.

3.3. Third Semester Courses

3.3.1. BM-HSM-201 ENGINEERING ECONOMICS AND MANAGEMENT 3-0-0=3

Subject Code: BM-HSM-201
Subject Name: *Engineering Economics and Management*
No. of Hours Per Week: *Lectures-3, Tutorial-0*
Marks Distribution: *Sessional Works = 30, End Semester Examination = 45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of examination: Two and half hour

Course Objectives

1. To introduce students to fundamental economic concepts and techniques applicable to engineering decision-making.
2. To develop students' skills in financial analysis and cost estimation for engineering projects.
3. To provide students with an understanding of management principles and strategies essential for effective leadership and project management in engineering organizations.

Course Outcomes

1. Students will be able to apply economic principles and financial analysis techniques to evaluate engineering projects and make informed decisions.
2. Students will develop proficiency in cost estimation methods and financial modeling for engineering projects, enabling them to assess project feasibility and profitability.
3. Students will gain insights into management principles, leadership styles, team dynamics, and organizational behavior in engineering contexts, enhancing their ability to lead and manage engineering projects and teams effectively.

UNIT I

Introduction to Engineering Economics, Definition and scope of engineering economics, Economic decision-making process, Time value of money concept, Principles of Financial Analysis, Cash flow diagrams and analysis, Interest rates and present value, Future worth and annual worth analysis

UNIT II

Cost Estimation Techniques, Cost classification and categorization, Cost estimation methods: historical data, analogies, parametric, and engineering estimates, Sensitivity analysis and uncertainty in cost estimation Financial Analysis and Investment Decision Making, Payback period method, Net present value (NPV) analysis, Internal rate of return (IRR) analysis,Capital budgeting techniques, Risk and Uncertainty in Engineering Projects, Sources of uncertainty in engineering projects, Risk assessment and management techniques, Decision-making under uncertainty: expected monetary value (EMV) analysis,

UNIT III

Project Management Principles and Practices, Project lifecycle and phases, Project planning, scheduling, and budgeting, Project monitoring and control, Leadership and Organizational Behavior, Leadership styles and traits, Team dynamics and group decision-making, Organizational culture and change management, Strategic Management in Engineering Organizations, Strategic planning process, SWOT analysis, Competitive analysis and positioning.

Textbooks

1. P. A. Samuelson and W. D. Nordhaus, "Economics," 19th ed. New York, NY, USA: McGraw-Hill Education, 2009.
2. C. S. Park, "Contemporary Engineering Economics," 6th ed. Upper Saddle River, NJ, USA: Pearson, 2015.

Reference Books

1. D. G. Newnan, T. G. Eschenbach, and J. P. Lavelle, "Engineering Economic Analysis," 13th ed. Oxford, UK: Oxford University Press, 2015.
2. W. J. Stevenson, "Operations Management," 12th ed. New York, NY, USA: McGraw-Hill Education, 2014.

3.3.2. BM-BS-203 ENGINEERING CHEMISTRY 3-0-0 = 3

***Course Code**: BM-BS-203*
***Course Name:** Engineering Chemistry*
***No. of hours per week**: Lecture - 3*
***Mark distribution:** Internal Assessment = 30, End semester examination = 45*
***Questions to be set:** (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
***Questions to be answered:** Any five*
***Duration of the end semester examination**: Two and half-hour*

Course Objectives

1. To understand various concepts of chemistry and their applied aspects in and around us.
2. A better understanding about thermodynamics and time dependent study of reactions with certain examples around us.
3. To understand the applied aspects of technology in natural and man-made polymeric molecules.
4. Rationalization of bulk properties and processes using thermodynamic considerations.
5. To learn about the significance of water in our life in various ways one of the most potential matrices of environment, at the constant risk of man-made hazards, and also the water hazards to industries and remedy.

Course Outcomes

6. Quantification of several concepts of chemistry that were introduced at school levels till the higher secondary standard.
7. Equipped with the knowledge of the chemical processes in terms of the basic principles of heat transfer, time dependent study at molecular levels through ionic interactions.
8. Gaining a clarity about the applied aspects of technology in natural and man-made polymeric molecules.
9. Proper understanding about the proper handling of water for personal and industrial use, remedial measures of pollution and optimization of natural resources of water.

UNIT - I
Chemical Thermodynamics: Second law of thermodynamics, entropy and its physical significance, entropy change of ideal gases, free energy, Maxwell's relations, Gibbs-Helmholtz equation, thermodynamic equilibrium, Van't Hoff equation, Clausius-Clapeyron equation.

UNIT – II

(a) *Catalysis:* Action of a catalyst, types of catalysts, acid-base catalysis, enzyme catalysis.

(b) *Chemical Kinetics*: Rate laws of zero, first and second order reactions with examples, reactions above third order, pseudo-uniorder reaction, collision theory and activation energy, role of a catalyst in a reaction.

UNIT – III
Application of Chemistry in Engineering

(a) *Polymers*: Types of Polymerization; Classification and structures of polymers; application of a few commercially important artificial polymers (like Nylons, Polyester, Polyurethane, Rubber, Teflon, PVC, Polycarbonate, Bakelite, Silicones).

(b) *Applications of Electrochemical cells*: EMF and its applications, commercially important cells, Corrosion - electrochemistry of rusting of iron and remedial measures.

Text books:

1. Prakash, Tuli, Basu and Madan, *Advanced Inorganic Chemistry, Vol. I & II* (Diamond Ed.), S.Chand, reprinted, 2006.
3. Jain & Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Co., 2008.
3. Levine, *Physical Chemistry*, 5/e (7th reprint), Tata McGraw Hill, 2006.

Reference Books:

1. Shriver, Atkins and Langford; *Inorganic Chemistry*, 5/e, ELBS, 2009.
2. S.S. Dara, *A Textbook Engineering Chemistry*, Publ. S. Chand & Company Pvt. Ltd., New Delhi, 2007.

3.3.3. BM-ES-205 BASIC ELECTRONICS 3-1-0=4

Subject Code: *BM-ES-205*
Subject Name: *Basic Electronics.*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination*: Three Hours.*

Course Objectives

1. To introduce students to the fundamental principles of electronics, including electronic components such as resistors, capacitors, and transistors, as well as basic circuit analysis techniques such as Ohm's law and Kirchhoff's laws.
2. To familiarize students with the application of electronic principles in biomedical engineering, including the design and operation of medical devices such as electrocardiographs, medical imaging systems, and patient monitoring devices.
3. To develop students' problem-solving skills in electronic circuit design, analysis, and troubleshooting through hands-on laboratory experiments, simulations, and practical projects relevant to biomedical engineering applications.

Course Outcomes

1. Upon completion of the course, students will be able to analyze simple electronic circuits using fundamental principles and techniques, including voltage and current division, nodal and mesh analysis, and transient and steady-state response analysis.
2. Students will demonstrate an understanding of how electronic principles are applied in the design, operation, and troubleshooting of biomedical devices, such as signal conditioning circuits for biosensors, amplifiers for physiological signals, and digital signal processing techniques for medical imaging.
3. By completing laboratory exercises and projects, students will gain the ability to design and implement basic electronic circuits relevant to biomedical engineering, including analog and digital circuits for signal processing, filtering, amplification, and data acquisition in medical instrumentation systems.

UNIT – I

Passive components: Resistors, capacitors and inductors: types and characteristics and their applications. Semiconductors: Energy bands in silicon, intrinsic and extrinsic, carriers transport in silicon: diffusion current, drift current, mobility and resistivity. Generation and recombination of carriers, Semiconductor materials. PN junction diode: General idea of a PN junction diode, Reverse and forward biased characteristics, Transition capacitance and diffusion capacitance.

UNIT – II

PN Junction diode applications: Half wave rectifier, full wave center- tapped and bridge rectifier Clipping and clamping circuits. Introduction to Special purpose diode characteristics and applications: Zener diode, Photo diode, Varactor diode, Light emitting diode, Schottky diode, Tunnel diode.

UNIT – III

BJT, FET (JFET & MOSFET) and UJT: Construction, symbols, principle of operation, different configurations, study of characteristics, limitations and applications, Application of BJT as amplifiers. Biasing and stabilization of BJT: Q point, Graphical analysis (DC and AC load line), fixed bias, collector bias, self-bias.

UNIT – IV

Digital Electronics: Number systems and codes, logic gates, Boolean theorems, De-morgan's theorems, Boolean algebra, minimization of Boolean functions; Karnaugh map up to four variables.

Text Books

1. Boylestead and Nashelsky, Electronic Devices and Circuits Theory, 9/e, PHI, 2006.

2. Bernard Grob and Mitchel Schultz, Basic Electronics, 9/e, TMH, 2003.

3. Morris Mano, Digital Design, 3/e, PHI, 2006.

4. J. Millman and C. C. Halkias, Integrated Electronics, 42nd Reprint, TMH, 2006.

Reference Books

1. A. P. Malvino, Electronic Principles, 6/e, TMH, (Latest edition).

2. R. P. Jain, Modern Digital Electronics, 3/e, TMH, 2003.

3. R. J. Tocci, Digital Systems, 6/e, PHI, 2001.

3.3.4. BM-PC-207 BIOMEDICAL INSTRUMENTATION-I 3-1-0=4

Subject Code:*BM-PC-207*
Subject Name: *Biomedical Instrumentation-I*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination*: Three Hours.*

Course Objectives:

1. Understanding the fundamental principles of biomedical instrumentation and its applications in healthcare.
2. Exploring various biomedical sensors and their mechanisms of operation.
3. Learning about the design, operation, and applications of medical imaging devices.

Course Outcome:

1. The course outcome for Biomedical Instrumentation typically aims to equip students with the knowledge and skills necessary to understand, design, and utilize instruments used in biomedical applications.

2. This includes understanding the principles behind various medical devices, signal processing techniques for biomedical signals, regulatory standards, and ethical considerations.

3. Ultimately, students should be able to apply their knowledge to solve real-world biomedical engineering problems effectively.

UNIT I:

Bioelectric Amplifiers: Introduction, characteristics, and Special features of bioelectric amplifiers, Safety requirements, Realization of bioelectric amplifiers, Carrier amplifiers, Chopper amplifiers, Phase-sensitive detectors, Isolation amplifiers, Instrumentation amplifiers. Cascading of Amplifiers, Coupling schemes (RC coupling and Transformer coupling).

UNIT II:

Biomedical Transducers and Bio electrodes: Bio electrodes for ECG, EEG, and EMG with the study of ECG/EEG/EMG in detail as a sample case, Recording of ECG, EMG, EEG signal and their characteristics, Introduction and characteristics of bio-signals, Holter monitor and cardiac stress test. Transducers: Temperature, Pressure, Displacement, Position, Motion, Humidity, Moisture. Skin resistance measurements, catheter transducer, photoelectric transducer, piezoelectric transducer.

UNIT III:

Patient Monitoring System: Different components of patient monitoring system, Foetal monitoring instrument, Multi parameter(s) patient monitor. Computer-assisted patient monitoring, Blood pressure, heart sound, heart rate measurements, variability, sources of signal artifact, and their implications.

UNIT IV:

Analytical and Diagnostic Instruments: Common analytical equipment used in hospitals and Biochemistry laboratories, blood flow meters, cardiac output measurement, Pulmonary function analyzers, Different types of oximetry systems, circuits of pulse oximetry, constant current source, current–voltage converter, and blood cell counters. Patient safety, Computer-aided biopsy.

Text Books:

1. Carr and Brown, "Introduction to Biomedical Equipment Technology", 4th Edition Pearson Education, 2000.

2. W Leslie Cromwell "Biomedical Instrumentation and Measurements", 2nd Edition,2010, PHI.

3. John G Webster, "Bioinstrumentation", Wiley and Sons, 2008.

4. R. B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", 2nd Edition, CRC Press, 2012.

Reference Books:

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg,Boston, 1986.

2. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 3rd Edition, Tata McGraw Hill, 2014.

3.3.5. BM-BS-LC-209 ENGINEERING CHEMISTRY LABORATORY 0-0-4 = 2

Course Code: *BM-BS-LC-209*
Course Name: *Engineering Chemistry Laboratory*
Contact hours per week: *Practical- 4*
Distribution of Marks: *Internal Assessment = 20, End semester examination = 30*
Minimum number of experiments to be performed: *Ten*
Questions to be answered: O*ne on lottery basis*
Duration of the end semester examination: *Three hours*

Course Objectives

1. Exposure to a chemistry lab culture – the do's and don'ts, with an emphasis on performance with care and caution.
2. Learning of and practising the respect to chemicals, glassware and equipment – handling, maintenance and optimization of resources.
3. Enhancement of theoretical knowledge through do it yourself (DIY) experience.
4. Learning various techniques of qualitative and quantitative analyses, useful in chemistry

Course Outcomes

1. To experience the principles of chemistry in reality by verifying them, relevant to the study of science and engineering.
2. Quantitative and analytical study of the properties of matter (solid, liquid, solution, mixture).
3. Analysis of an unknown organic compound, the basis of life around human being.
4. Analytical study of water, one of the most essential components of environment.

List of Experiments:

1. Standardisation of the given Mg^{2+} solution by EDTA titration (complexometric titration).

2. Standardisation of $KMnO_4$ solution by oxalic acid solution.

3. Volumetric estimation of Mg^{2+} and Ca^{2+} ions by EDTA titration (Hardness of water).

4. Volumetric estimation of Fe^{2+} ions by permanganatometry.

5. Determination of composition of the given liquid mixture by viscosity measurement.

6. Standardization of strong base by conductometric titration method using a strong acid.

7. Experimental verification of Hasselbach-Henderson equation by pH measurement and to determine the dissociation constant of weak acid.

8. Verification of Beer-Lambert law with potassium permanganate and the estimation of potassium present in the given solution.

9. Verification of cell constant of the given conductivity cell with the help of known KCl solutions and to determine the concentration of the given KCl solution conductometrically.

10. Determination of λ_{max} of $KMnO_4$, $K_2Cr_2O_7$ and K_2CrO_4 in aqueous solution, spectrophotometerically and determination of molar absorption coefficient of each compound of potassium.

11. Conductometric determination of the rate constant of the second order reaction of saponification of an ester by NaOH.

12. Determination of alkalinity of water used for industry.

Text books:

1. Pandey, Bajpai and Giri, *Practical Chemistry* (reprinted), S.Chand & Co. Ltd., 2006.

2. Dr. Sunita Rattan, *Experiments in Applied Chemistry,* S.K.Kataria & Sons Publishers, New Delhi 2012.

3. M.S. Kaurav, *Engineering Chemistry with Laboratory Experiments*, PHI Learning Pvt. Ltd. Publishers, New Delhi, 2011.

Reference Books:

1. Gurtu & Kapoor, *Advanced Experimental Chemistry*, Vol.I & II, 4/e, (reprinted), S.Chand & Co. Ltd., 1989.
2. *Vogel's Textbook of Quantitative Chemical Analysis*, 5/e, ELBS, 1991.
3. *Vogel's Textbook of Practical Organic Chemistry*, 5/e, ELBS, 1996.
4. Banwell & McCash, *Fundamentals of Molecular Spectroscopy*, 4/e, Tata Mc Graw Hill, 1962.

3.3.6. BM-PC-LC-211 BIOMEDICAL INSTRUMENTATION LABORATORY-I 0-0-4=2

Subject Code:*BM-PC-LC-211*
Subject Name: *Biomedical Instrumentation Laboratory-I*
No. of Hours Per Week: *Practical-4*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten.*
Question to be answered: *One experiment will be allotted to a student on a lottery basis.*
Duration of End Semester Examination*: Three Hours.*

Course objective:

1. Providing hands-on experience with a variety of biomedical instruments commonly used in clinical and research settings.
2. Familiarizing students with the operation, calibration, and maintenance of biomedical equipment.
3. Practicing data acquisition and signal processing techniques for biomedical signals like ECG, EEG, and EMG.
4. Learning to design and conduct experiments to analyze and interpret biomedical data.

Course Outcomes:

1. The course outcome for the Biomedical Instrumentation Laboratory typically aims to provide students with practical skills and hands-on experience in working with biomedical instruments. This includes proficiency in operating, calibrating, and maintaining various medical devices, as well as acquiring, processing, and analyzing biomedical signals. Additionally,
2. Students should develop problem-solving abilities, an understanding of safety protocols and regulatory standards, and the capability to design and conduct experiments to address biomedical engineering challenges effectively. Ultimately, the course aims to prepare students for careers in biomedical research, healthcare, or further studies in related fields.

List of Experiments:

1. Measurement of waveform, amplitude, durations, and frequency using CRO, triggering of the beam with an external signal.
2. Record the ECG signal, and its characteristics and calculate the heart rate of the subject.
3. Investigate the EMG signal and its characteristics.
4. Investigate EEG Signal, to measure the amplitude-frequency concerning external stimulus.
5. Non-invasive blood pressure measurement using aneroid and mercury sphygmomanometer.
6. Non-invasive blood pressure measurement using a computer-aided system.
7. Investigate the heart sounds using a computer-aided microphone (or Electronic stethoscope)
8. Characterize various heart sounds.
9. Study of multipara meter patient monitor.

10. Measurement of galvanic skin resistance and its characteristics.

Text Books:

1. Carr and Brown, “Introduction to Biomedical Equipment Technology”, 4th Edition Pearson Education, 2000.

2. W Leslie Cromwell “Biomedical Instrumentation and Measurements”, 2nd Edition, 2010, PHI.

3. John G Webster, “Bioinstrumentation”, Wiley and Sons, 2008.

Reference Books:

1. Joseph Bronzino, “Biomedical Engineering and Instrumentation”, PWS Engg, Boston, 1986.

2. R. S. Khandpur “Handbook of Bio-Medical Instrumentation”, 3rd Edition, Tata McGraw Hill, 2014.

3.3.6. BM-PC-LC-213 ENGINEERING DESIGN AND 3D PRINTING LABORATORY 0-0-4 = 2

Subject Code: *BM-PC-LC-213*
Subject Name: *Engineering Design and 3D Printing Laboratory*
No. of Hours Per Week: *Practical-4*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
Questions to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours.*

Course objectives

1. Familiarize students with fundamental principles and methodologies of engineering design, including problem identification, concept generation, and prototype development.
2. Provide hands-on experience in applying engineering design processes, such as needs assessment, brainstorming, feasibility analysis, and design validation.
3. Provide practical training in operating 3D printers, CAD (Computer-Aided Design) software, and related tools for designing and prototyping.

Course outcomes

1. Upon completion of the laboratory sessions, students will demonstrate proficiency in applying engineering design principles and methodologies to solve complex engineering problems.
2. They will be able to identify design requirements, develop conceptual designs, and iteratively refine solutions through prototyping and testing.
3. Students will gain mastery of 3D printing technology, including its principles, processes, materials, and applications.
4. They will demonstrate proficiency in operating 3D printers, utilizing CAD software for design, and optimizing print parameters to achieve desired outcomes.

List of Experiments

1. To design simple 3D models (Cube, cuboid, sphere etc.) in CAD software, focusing on printability for FDM
2. To utilize advanced modelling features like Boolean operations (unions, cuts) for complex designs.
3. To study the working principle of FDM printer
4. To study the working principle of SLA printer
5. To study the working principle of SLS printer
6. To perform slicing on develop CAD model with different slicer settings (infill density, layer height, printing temperature) and analyse their impact on print quality and time.
7. To perform 3D scanning with standard scanner and generate STL file.
8. To perform 3D printing of designed medical tools/equipment/others using FDM printer.
9. To perform 3D printing of designed medical tools/equipment/others using SLA printer.
10. To perform 3D printing of designed medical tools/equipment using SLS printer.
11. To perform composite metal printing using FDM or SLM printing method.

Text Books

1. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
3. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
4. Prabhat Chaudhari, Dinesh Bhatia, Jitendra Sharan, 2021, "3D Printing in Oral Health Sciences" Springer Nature, Singapore

Reference Books

1. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013.
2. Prabhat Chaudhari, Dinesh Bhatia, Jitendra Sharan, 2021, "3D Printing in Oral Health Sciences" Springer Nature, Singapore
3. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
4. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012

3.3.7. BM-AU-215 INDIAN CONSTITUTION 2-0-0 = 0

Subject Code: BM-AU-115.
Subject Name: Indian Constitution
No. of Hours Per Week: Lectures-2, Tutorial-0.
Marks Distribution: Continuous Assessment: 50

Course Objective:
1. The Constitution of India is the noble document felicity the vision of the Government and has guaranteed the Fundamental rights of the citizen along with fundamental duties.
2. The constitution of India carries the legacy of the deeply rooted culture of the level and uphold the cherished goal of offering integrity of the nation and unity among the diversity of the country. The course will help the students to learn their constitutional rights and duties.

Course Outcomes:
1. Students will understand about Fundamental rights of the citizen along with fundamental duties.
2. Students will understand about their constitutional rights and duties.

UNIT-I

Fundamental Aspect of the Constitution: The preamble, Form of constitution, Features of Indian Constitution, Citizenship (Part II), Fundamental Rights (Part III) : Directive Principle of state policy (Part IV), Fundamental Duties (Part IV-A), The Union (Part V), The States (Part VI), The Panchayat (Part IX), The municipalities (Part IX-A) The Schedule and Tribal Areas (Part X), Tribunals (Part6 XIV-A)

UNIT–II

Emergency provisions (Part XVIII), Amendment of the Constitution (Part XX), Schedules: Fifth Schedule, Sixth schedule, seventh schedule, Eight Schedule,

Text Books:
1. H.K. Saheray, Indian Constitutional Law. New Delhi: Eastern Book Company, 2022.
2. M.B. Jain, Indian Constitutional Law. Lucknow: Eastern Book Company, 2019.

Reference Books:

1. Subhash C. Kashyap, Our Constitution: An Introduction to India's Constitution. Agra: Anand Books, 2020.
2. P.K. Agarwal and K.N. Chaturvedi, Constitution of India. New Delhi: Universal Law Publishing, 2018.

4.4. Fourth Semester

4.4.1. BM-BS- 302 STATISTICS AND RANDOM PROCESSES 3-1-0=4

Subject code: *BM-BS- 302*
Subject Name: *Statistics and Random Processes*
No of Hours per week: *Lectures 3, Tutorials 1*
Marks distribution: *Sessional works = 40, End Semester examination = 60*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five*
Duration of end semester examination: *Three Hours.*

Course Objectives

1.To understand the basic of probability theory.

2. Identify different distribution functions and their relevance.

3. To understand Stochastic Processes

Course outcomes

1. Apply the concepts of probability theory to different problems.

2. To analyze various Stochastic processes and used use them for process characterization.

UNIT I

Introduction to probability : Events, Set, set operations, classical and relative frequency based definitions of probability, axiomatic definition of probability, conditional probabilities, independence, total probability, Baye's rules and applications, Repeated trails. Random variables : Continuous and discrete random variables, cumulative distribution function (cdf), probability mass function(pmf), probability density functions(pdf) and properties.

UNIT II

Some special distributions: Binomial and Poisson discrete distributions, Uniform, exponential, Gaussian and Raleigh continuous distributions. Expected value of a random variable(s), mean, variances and moments of random variables. Function of single random variable. Moment generating and characteristic functions and their applications. Chebyshev Inequality. Orthogonal random variables.

UNIT III

Two-dimensional random variables: joint distribution and density functions, marginal probability distribution, conditional probability distribution, independence. Functions of two random variables. Multivariate random variables, covariance and correlations, independence. Multivariate Gaussians distributions, vector- space representation of random variables. Inner product, Schwarz inequality. Sequence of random variables: almost sure and mean square convergence, convergence in probability and distribution, law of large numbers, central limit theorem.

UNIT IV

Random Proccess: Discrete and continuous time processes, probabilistic description of random process, mean, auto correlation and auto covariance functions. Stationarity: strict sense stationary (SSS), wide sense stationary

(WSS) processes, auto correlation functions of a WSS process and its properties, Cross correlation functions. Power spectral densities and properties. Gaussian process, Poison process and Markov processes.

Text Books

1. A, Papoulis and S.U. Pillai, "Probability, Random variables and Stochastic process", 4 ed, Mc Graw Hill, 2002.
2. A Leon Gracia. . 'Probability and Random Processes with applications to Signal Processing, 3rd edition, Pearson Education, 2008

Reference Books

1. P.Z, Pebbles, "Probability, random variables and random signals principles", 4ed, Mc Graw Hill, 2000.
2. T, Veerarajan, "Probability, statistics and random processes",2ed, Mc Graw Hill, 2003.

4.4.2. BM –PC-204 BIOMEDICAL INSTRUMENTATION –II 3-1-0=4

Subject Code: *BM –PC-204.*
Subject Name: Biomedical Instrumentation –II
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Three*

Course Objective:

1. To give knowledge regarding principle of operation and design of biomedical instruments.
2. To enhance the skill for Maintenance , repairing & use of medical equipment optimally

Course outcome:

1. Learn about the design, and functioning of Cardiac Pacemakers and Defibrillators.
2. Knowing about the various therapeutic equipments and how they are applied.
3. Learning about the ventilation and anaesthetic system in healthcare.

UNIT I

Cardiac Pacemakers & Defibrillators: External, internal, and programmable pacemakers. Pulse generator- sensing, output and timing circuits. electrodes and leads system, pacing system analyzers. Defibrillators- basic principle and comparison of output wave forms of different DC defibrillator, energy requirements, synchronous operation, implantable defibrillators, treatment for arrhythmias.

UNIT-II

Physiotherapy Equipment's:
Nerve-muscle stimulator: peripheral nerve stimulator, Ultrasonic stimulators, stimulators for pain and relief. Diathermy: IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy, Surgical Diathermy.

UNIT-III

Therapeutic Equipment: Physics and engineering of lithotripters. Principle andBiomedical Hemodialysis machine, heart lung machine, LINAC, Baby incubator.

UNIT-IV
Ventilators and Anesthesia System: Basic principles of ventilators, different generators, inspiratory phase and expiratory phase. Anesthesia: Need of anesthesia, gas used and their sources, gas blending and vaporizers, anesthesia delivery system, breathing circuits.

Text Book

1. J.Webster, "Bioinstrumentation", *Wiley & Sons*, 2004.

Reference Books

1. J. Bronzino, " Biomedical Engineering and Instrumentation", *PWS Engg*.
2. L. Cromwell, " Biomedical Instrumentation and Measurements",*Pearson Education*, 1990.
3. R. S. Khandpur, "Handbook of biomedical engineering", *TataMcGraw-Hill*, 1987.

4.4.3. BM-PC-206 SIGNALS AND SYSTEMS 3-1-0=4

Subject Code: *BM– PC-206*
Subject Name: *Signals and Systems*
No. of Hours Per Week: *Lectures-3,Tutorial-1*
Marks Distribution: *Sessional Works=40, End Semester Examination=60.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. To learn about system behavior through mathematical models such as impulse response, transfer functions, and convolution, and analyzing system properties such as impulse response, frequency response, and stability.
2. To Learn about frequency domain representation of signals and systems using Fourier series, Fourier transform, Laplace transform, and Z-transform, and analyzing frequency response and filtering properties.
3. To learn about Fourier series, Fourier transform, Laplace transform, and Z-transform to analyze signals and systems in both continuous-time and discrete-time domains

Course Outcomes

1. Students should understand system behavior through mathematical models such as impulse response, transfer functions, and convolution, and analyzing system properties such as impulse response, frequency response, and stability.
2. Students can understand the frequency domain representation of signals and systems using Fourier series, Fourier transform, Laplace transform, and Z-transform, and analyzing frequency response and filtering properties.
3. Students also applying techniques such as convolution, differential equations, and difference equations to analyze signal and system behavior in the time domain.

UNIT– I

Introduction: Signals and systems, Examples of signals and systems; Signal types: Energy and power signals, Continuous and discrete time signals, Analog and digital signals, Deterministic and random signals; Signal properties: Symmetry, Periodicity, absolute integrability. Systems and system properties: Linearity, Shift-invariance, Causality, Stability, Realizability; Continuous time and discrete time linear shift-invariant (LSI) systems: The impulse response and step response; Response to arbitrary inputs: Convolution, Interconnections; Characterization of causality and stability of linear shift-invariant systems;

UNIT– II

Signal Representation: Signal space and orthogonal bases of signals, Fourier series representation; Fourier Transform and properties, Parseval's Theorem, Time-bandwidth product; Phase and group delays; Hilbert transform, pre- envelope. Spectral Analysis: Energy, Power, Parseval's theorem, Energy, Power Spectral density functions (PSDF), The Autocorrelation function, Cross correlation function, Relationship between PSD function and auto correlation function.

UNIT– III

Network Analysis:- Complex Frequency, Laplace Transforms, Shifting theorems, Initial value theorem, final value theorem, Effects of differentiation and integration in time domain. System transfer function, poles and zeroes, Impulse response convolution, Transient and steady state analysis (R-L-C circuit), Solution of linear differential equation.

UNIT– IV

Discrete Signals:-Introduction, z-transform and Inverse z-transforms, Relation between s–plane and z–plane. Shifting theorem. Initial value theorem and final value theorem, Transfer function of delay unit, Realization of z-domain transfer function, Unit sample response convolution. Solution of difference equations and its applications in biomedical domain.

Text Books

1. A.V. Opponheim, A.S. Willsky and Nawab, “Signals and Systems”, 2nd Edition, PHI, 2006.

2. Robert A. Grabel and Richard A. Roberts, “Signals and Linear System”, John Willey and Sons, 1987.

Reference Books

1. R.F. Ziemer, W.H. Tranter and D.R. Fannin, “Signals and Systems – Continuous and Discrete”, 4th Edition, PHI, 2005.

2. I. J. Nagrath, S.N. Saran, R. Ranjan and S. Kumar, “Signals and Systems”, TMH, 2001.

4.4.4. BM-PC-208 BIOMATERIALS 3-1-0=4

Subject Code:*BM-PC-208*
Subject Name: *Biomaterials*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination*: Three Hours.*

Course Objectives

1. To learn about biomaterials and their classification, important properties of materials for use in the body and how the body interacts/ reacts with these materials.
2. To learn about the application and characteristics of metal and polymers as biomaterials.
3. To learn about the application and characteristics of Ceramics and composite as biomaterials.
4. To learn about biocompatibility and toxicological screening of biomaterials, and different types of sterilization techniques.

Course Outcomes

1. To gain knowledge about the different types of biomaterials like Metal, Polymers, Ceramics, and Composite and their medical applications.

2. To gain knowledge about material properties and sterilization techniques required for different applications.

UNIT I

Introduction: Definition of biomaterials, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intravascular system). Surface properties of materials, physical properties of materials, mechanical properties.

UNIT II

Metallic implant materials: Introduction to Metallic, Host tissue reaction, corrosion behaviour, tissue adhesion. Hard tissue replacement implant: Orthopaedic implants, Dental implants. Polymeric implant materials, Polyolefins, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers Viscoelastic behaviour: creep-recovery, stress-relaxation, strain rate sensitivity. Synthetic polymeric membranes and their biological applications:

UNIT III

Ceramic and Composite implant materials: Definition of bio ceramics. Common types of bio ceramics: Aluminium oxides, Glass ceramics, Carbon based materials. Bioresorbable and bioactive ceramics. Host tissue reactions: importance of interfacial tissue reaction. Mechanics for improvement of properties by incorporating different elements. Composite theory of fibre reinforcement.

UNIT IV

Biocompatibility and toxicological screening of biomaterials, Sterilization Methods for different materials. In vitro testing (Mechanical testing): tensile, compression, wear, fatigue, corrosion studies and fracture toughness. Biomaterials characterizations technique: Rheology, AFM, SEM, TEM, FTIR, XRD.

Text Books:

1. Buddy D. Ratner, "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press, San Diego, 2012

2. Sujata V. Bhat, "Biomaterials", Narosa Publishing House, 2002

Reference Books:

1. J B Park, "Biomaterials - Science and Engineering", Plenum Press, 2013

4.4.5. BM-PC-LC-210 BIOMATERIALS LABORATORY 0-0-4= 2

SubjectCode:*BM-PC-LC-210*
Subject Name: *Biomaterials laboratory*
No. of Hours Per Week: *Practical-4*
Marks Distribution: *Sessional Works=20, End Semester Examination=30.*
Questions to be set: *Ten*
Questions to be answered: *Any one based on lottery basis*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. To develop the basic skills for handling different types of equipment.
2. To develop the basic skills of cell culture.
3. To learn the synthesis procedure of different biomaterials and their applications.
4. To learn the safety features of laboratory instruments.

Course Outcomes

1. They gain hands-on experience of cell culture.
2. They gain knowledge about the working principles of different Instruments.
3. They may acquire practical experience of handling different equipment
4. They may develop skills to design and conduct experiments, as well as analyze and interpret data

List of experiments:

1. To perform optical microscopy and quantitative image analysis
2. To perform Fabrication of Metal Implant and Testing
3. To perform Fabrication of polymer Implant and Testing
4. To perform Fabrication of Ceramics Implants and Testing
5. To perform Fabrication of Composite Implants and Testing
6. To perform Tensile Testing of Biomaterials Using UTM
7. To perform Spectophometric Analysis of biomaterials.
8. To perform Basic Techniques in Mammalian Cell Culture.
9. To perform Florescence Microscopy Analysis
10. To perform Zeta potential analysis
11. To perform XRD analysis
12. To perform FTIR Analysis.

Text Books:

1. Buddy D. Ratner, “Biomaterials Science: An Introduction to Materials in Medicine”, Academic Press, San Diego, (latest edition). Year
2. Sujata V. Bhat, “Biomaterials”, Narosa Publishing House, (latest Edition). Year
3. J B Park, “Biomaterials - Science and Engineering”, Plenum Press, (latest edition). Year

Reference Books:

1. Lawrence Stark and Gyan Agarwal, “Biomaterials”, Plenum Publishing Corporation, (Latest Edition). Year
2. L. Hench & E. C. Ethridge, “Biomaterials - An Interfacial approach” Volume 19, Issue 5, Willey India, (Latest Edition). Year

4.4.6. BM-PC-LC- 212 BIOMEDICAL INSTRUMENTATION – II LABORATORY 0-0-4=2

Subject Code: *BM-PC-LC-212*
Subject Name: Biomedical Instrumentation – II Laboratory
No. of Hours Per Week: *Practical-4*
Marks Distribution: *Sessional Works=20, End Semester Examination=30.*
Questions to be set: Ten
Questions to be answered: *Any one.experiment based on lottery*
Duration of End Semester Examination: *Three Hours*

Course objective:

1. Providing hands-on experience with a variety of biomedical instruments commonly used in clinical and research settings.
2. Familiarizing students with the operation, calibration, and maintenance of biomedical equipment.
3. Practicing data acquisition and signal processing techniques for biomedical signals like Defibrillators, Pacemaker, Holter monitor, Ventilators, etc.
4. Learning to design and conduct experiments to analyze and interpret biomedical data.

Course Outcomes:

1. The course outcome for the Biomedical Instrumentation Laboratory typically aims to provide students with practical skills and hands-on experience in working with biomedical instruments. This includes proficiency in operating, calibrating, and maintaining various medical devices, as well as acquiring, processing, and analyzing biomedical signals.
2. Students should develop problem-solving abilities, an understanding of safety protocols and regulatory standards, and the capability to design and conduct experiments to address biomedical engineering challenges effectively. Ultimately, the course aims to prepare students for careers in biomedical research, healthcare, or further studies in related fields.

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List of Experiments

1. Investigate the operation of Pacemaker Circuits.

2. Investigate the operation of Defibrillators.

3. Investigate the operation of Holter monitor.

4. Investigate the operation of Ventilators.

5. Investigate the operation of Treadmill, design a protocol for cardiac stress test.

6. Demonstration of operation and trouble shooting of Heart lung machine.

7. Investigate the Audiometer.

8 Investigate the spirometry

9. Investigate the lung volume and capacities.

10. Investigate the lithotripter.

Text Books

1. John G Webster, “Bioinstrumentation”, Wiley and Sons, 2008.

2. Carr and Brown, “Introduction to Biomedical Equipment Technology”, 4th Edition

Pearson Education, 2000.

Reference Books

1. R. S. Khandpur, “Handbook of Bio-Medical Instrumentation”, 3rd Edition, Tata McGraw Hill, 2014.

2. Joseph Bronzino, “Biomedical Engineering and Instrumentation”, PWS Engg, Boston, 1986

5.5. Fifth Semester Courses

5.5.1. BM-PC-301 ARTIFICIAL INTELLIGENCE IN HEALTHCARE 3-1-0 = 4

Subject Code:*BM-PC-301*
Subject Name: *Artificial Intelligence in Healthcare*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course objective:

To familiarize

1. Basic concept of Artificial Intelligence.
2. Various steps involved in Artificial Intelligence.
3. Basic concept of Expert Systems.

Course outcome:

1. Understand the fundamentals of artificial intelligence and its applications in healthcare.
2. Explore ANN and deep learning architectures relevant to healthcare data.
3. Learn how AI techniques are applied to medical imaging analysis and diagnostics.
4. Develop skills in building predictive models for disease prediction and prognosis.

UNIT-I

Introduction to Artificial Neural Networks (ANN): Feature selection. Types of learning, Supervised and unsupervised learning, Supervised learning decision surfaces, two category separation, Linearly separable sets, Multiple category classification problems. Relationship to neural network models, Comparison of methods, Applications.

UNIT-II

Convolutional Neural Networks (CNN): Introduction into Convolutional Neural Networks, Need for CNN, Architecture of CNN: Convolutional layer, Pooling layer, Output layer, Mathematics behind CNN: Transformation of data, Forward propagation and Backpropagation. Implementation of CNN: Using NumPy, Keras. R-NL, GSTM, GRU

UNIT III

Types of CNN: 2D CNN, 3D CNN, Fully Convolutional Neural Networks (FCN): DeepLab, SegNet, Cascaded FCN, U-Net: 2D-UNet, 3D-UNet, Res-UNet.

UNIT IV

Applications of AI in Healthcare: Analysis and classification of Bio-signals: ECG, EMG, EEG, Prediction of diseases, Medical Imaging: Detection and classification of diseases from medical images, Automatic medical image segmentation.

Text Books

1. D. L. Hudson and M. E. Cohen, "Neural Networks and Artificial Intelligence for Biomedical Engineering", *Prentice Hall of India*, 2011.

2. N. Buduma, "Fundamentals of Deep Learning: Designing Next-Generation MachineIntelligence Algorithm", *O'Reilly*, 2017.

3. G.R. Kanagachidambaresan, D. Bhatia, V. Dhilip Kumar, Animesh Mishra, 2022, "System Design for Epidemics Using Machine Learning and Deep Learning" Springer Nature, Switzerland, ISBN: 9783031197512.

4. I. Goodfellow, Y. Bengio and A. Courville, "Deep Learning", *MIT Press,* 2016.

Reference Books

1.A. Géron, "Hands-On Machine Learning with Scikit- Learn and TensorFlow", *O'Reilly,* 2017.
2. N. Ketkar, "Deep Learning with Python: A Hands-on Introduction", *Apress,* 2017.

5.5.2. BM-PC-303 BIOMECHANICS AND REHABILITATION ENGINEERING 3-1-0 = 4

Subject Code: *BM-PC-303*
Subject Name: *Biomechanics and Rehabilitation Engineering*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Students will develop a thorough understanding of fundamental biomechanical concepts and principles, including kinetics, kinematics, and mechanical properties of tissues.
2. They will learn how these concepts relate to human movement and the biomechanical aspects of rehabilitation, such as gait analysis, joint mechanics, and muscle function.
3. Students will learn to integrate biomechanical theories and principles into the development and implementation of rehabilitation programs.

Course Outcomes

1. Upon completion of the course, students will demonstrate a comprehensive understanding of fundamental biomechanical principles relevant to human movement and rehabilitation.
2. Students will be able to explain concepts such as kinetics, kinematics, mechanical properties of tissues, and their application to movement analysis and rehabilitation strategies.
3. Students will learn to integrate biomechanical theories and concepts into the development and implementation of rehabilitation programs.

UNIT I
Biomechanics: Introduction to biomechanics, kinesiology, basic mechanical concepts, types of motion, different types of body and joint movements. Basic kinetics and kinematics concepts, vectors and trigonometry, position of anatomical axis and corresponding movements of the body part.

UNIT II
Tissue Biomechanics: Solids and Structures: Biological Materials Properties, Viscoelasticity, Simple Structure, Hydrostatic Structure, Structural Systems, Biomechanical characteristic of bone and the soft tissue structure: tendons, ligaments, muscles, function and physiological factors.

UNIT III
Movement Biomechanics: Human Gait and its types, measurement and analysis of gait, body and limbs: mass and motion characteristics actions, forces transmitted by joints. Joints forces results in the normal and disabled human body, normal and fast gait on the level platform. Patterns: Push/Throw Continuum Biomechanics of push - like motions, Biomechanics of throw – like motions.

UNIT IV

Rehabilitation Engineering: Impairments, disabilities and handicaps. Measurement and assessment, prostheticsand orthotics: definition, role, classification and applications. Principles of three-point pressure, total constant and partial weight relieving, Design considerations for orthosis and prosthesis. Spinal orthosis, recent developments in prosthetics and orthosis designing and usage. Rehabilitation device for locomotion, visual, speech and hearing impaired persons. Study of manual and powered wheelchair with their applications.

Text Books

1. Sean P. Flanagan, Flanagan, "Biomechanics: A case based Approach", Jones andBartlett Publishers, 2013.
2. Meena Gupta, Dinesh Bhatia, Prakash Kumar, 2023 "Modern Intervention Tools For Rehabilitation", Elsevier Publishers, USA.
3. Y. C. Fung, Yuan-Cheng Fung, "Biomechanics: mechanical Property of livingTissue", Springer, 1996.
4. Carol A. Oatis, "The Mechanics and Pathomechanics of Human Movement",Lippincott Williams and Wilkins, 2010.

Reference Books

1. Prof. Ghista, "Biomechanics", Private Publication UAF, 2009.
2. White and Puyator, "Biomechanics", Private publication UAF, 2010.

5.5.3. BM- PC-305 BIOMEDICAL SIGNAL PROCESSING 3-1-0 = 4

Subject Code: *BM-PC-VIII-305*
Subject Name: *Biomedical Signal Processing*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Understanding the fundamental principles of signal processing and its application to biomedical signals.
2. Learning about different types of biomedical signals such as EEG, ECG, EMG, and their characteristics.
3. Exploring various signal-processing techniques used in analyzing and interpreting biomedical data.
4. Developing proficiency in digital signal processing methods including filtering, feature extraction, and time-frequency analysis.

Course Outcomes

1. The course outcome for Biomedical Signal Processing typically revolves around equipping students with the knowledge and skills necessary to effectively process and analyze biomedical signals. This includes understanding the theoretical foundations of signal processing, proficiency in applying various techniques to extract meaningful information from biomedical data, and the ability to interpret and analyze processed signals for diagnostic, monitoring, or research purposes.
2. Ultimately, the course aims to prepare students for roles in biomedical research, healthcare, or related fields where signal processing expertise is essential.

UNIT I

Discrete–Time Signals and Systems: Introduction of signals and systems; classification of signals, continuous time and discrete time signals, operations performed on them, even and odd signals, periodic and non-periodic signals, deterministic and random signals, energy signals, power signals, elementary signals: impulse, step, ramp and exponentials, classification of systems. A sampling of Analogue signals, Aliasing, Standard discrete-time signals, Classification, Discrete time system, Linear time invariant stable casual discrete-time systems, Classification methods, Linear and circular convolution, Difference equation representation, DFS, DTFT, DFT, FFT computations using DIT and DIF algorithms.

UNIT II

Infinite Impulse Response Digital Filters: Review of design of analog Butterworth and Chebyshev Filters, Frequency transformation in the analog domain, Design of IIR digital filters using impulse invariance technique, Design of digital filters using bilinear transform, Pre warping, Frequency transformation in the digital domain, Realization using direct, Cascade and parallel forms.

UNIT III

Finite Impulse Response Digital Filters: Symmetric and antisymmetric FIR filters, Linear phase FIR filters, Design using Frequency sampling technique, Window design using Hamming, Hanning, and Blackmann Windows, Concept of optimum equiripple approximation, Realization of FIR filters, Transversal, Linear phase, and polyphase realization structures.

UNIT IV

Analysis of Bio–Signals and Special Topics in BSP: Removal of artifacts-ECG, Event detection, ECG, P wave, QRS Complex, T wave, correlation analysis of ECG signals, Averaging of signals, PCG, ECG, and EMG. Heart rate variability analysis. Analysis of PCG signals, Analysis of Time variant systems, fixed segmentation, STFT, ACF, SEM, and GLR.

Text Books

1. John G. Proakis and Dimitris G. Manolakis, “Digital Signal Processing, Algorithms and Applications”, 3rd Edition PHI of India Ltd., New Delhi, 2000.
2. Rangaraj M. Rangayyan, “Biomedical signal processing: A Case Study”, IEEE Press,2002.

References Books

1. Sanjit K. Mitra, “Digital Signal Processing: A Computer Based Approach”, TataMcGraw-Hill, New Delhi, 1998.
2. A.V. Oppenheim, A.S. Willsky, and Nawab, “Signals and Systems”, 2nd Edition, PHI, 2006.

5.5.4. BM-PE-307X – PROGRAM ELECTIVE – I

5.5.4.1. (I) BM -PE-3071MEASUREMENTS AND CONTROL SYSTEMS 3-1-0=4

Subject Code: *BM -PE-3071*
Subject Name: *Measurement and control System*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objective:

1. To gain a comprehensive understanding of the fundamental principles underlying measurement systems, including accuracy, precision, resolution, and sensitivity.
2. Learn techniques for signal conditioning, including amplification, filtering, and analog-to-digital conversion. Understand how these techniques are used to improve the quality of measurement signals and enhance system performance.
3. Develop skills in modeling and simulating measurement and control systems using mathematical techniques and software tools. Learn how to validate models and use simulations for system analysis and design.

Course Outcome:

1. Students may Learn strategies for integrating measurement and control systems into larger systems and processes. Explore techniques for optimizing system performance, including calibration, tuning, and troubleshooting.
2. Students may apply measurement and control principles to real-world engineering problems and applications across various industries, such as manufacturing, automotive, aerospace, biomedical, and environmental monitoring.

UNIT I
Modeling of Systems: Terminology and basic structure of control system, Example of a closed loop system, Transfer functions, Modeling of electrical systems, Translational and rotational mechanical systems, and electro mechanical systems, Block diagram and signal flow graph representation of systems, Conversion of block diagram to signal flow graph, Reduction of block diagram and signal flow graph.
UNIT- II
Time Response and Stability Analysis: Step and impulse responses of first order and second order systems, Determination of time domain specifications of first and second order systems from its output responses, Definition of steady state error constants and its computations. Definition of stability, Routh- Hurwitz criteria of stability, Root locus technique, Construction of root locus and study of stability, Definition of dominant poles and relative stability.
UNIT - III
Frequency Response Analysis: Frequency response, Nyquist stability criterion, Nyquist plot and determination of closed loop stability, Definition of gain margin and phase margin, Bode plot, Determination of gain margin and phase margin using Bode plot, Use of Nichol's chart to compute response frequency and bandwidth.
UNIT- IV

Physiological Control System: Example of physiological control system, Difference between engineering and physiological control systems, Generalized system properties, Models with combination of system elements, Linear models of physiological systems Examples, Introduction to simulation.

Text Books:

1. Michael C K Khoo, "Physiological Control Systems", IEEE Press, Prentice Hall of India, 2001.
2. M. Gopal "Control Systems Principles and Design", Tata McGraw Hill, 2002.
3. John Enderle Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.

Reference Books:

1. Richard C. Dorf, Robert H. Bishop, "Modern control systems", Pearson, 2004.
2. L. Stark, "Neurological Control System", Plenum Press, 1968.

5.5.4.2. (II) BM -PE-3072 OPTICS IN MEDICINE 3-1-0=4

Subject Code: *BM -PE-3072*
Subject Name: *Optics in medicine*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objective

1. To gain a comprehensive understanding of the fundamental principles of laser operation

2. To study the components of laser systems, including gain media, optical resonators, pumping sources, and beam delivery systems

3. To learn about laser safety protocols, hazards associated with laser operation, and safety measures to protect personnel and equipment

Course Outcome

1. Students may understand the principles of fiber optics, including total internal reflection, light propagation, and modal dispersion.

2.Students may gain insight into emerging trends and technologies in laser and fiber optics, such as nonlinear optics, photonic crystals, optical amplifiers, and integrated photonics.

3. Students may explore the diverse applications of lasers in science, technology, industry, and medicine

UNIT I
Introduction to Fiber Optics: Basic fiber link, Applications, Principles of light: Introduction, EM spectrum, internal & external reflections, Snell' slaw, Optical fiber numerical aperture, Fresnel reflection.
UNIT II
Optic Fiber and its Properties: Introduction, Basic fiber construction, Propagation of light, Modes of operation, Refractive index profile, Types of fibers, Dispersion, Data rate and bandwidth, Attenuation, losses. Connectors, Splices & Couplers: Introduction, splices: Mechanical, fusion, Protection of splice, Connectors: SMA, STC, Bionic etc. Coupling: Passive, Stan, TEE types. Optical sources & Photo Detectors: Introduction: Creation of photons, LED, ILD.
UNIT III
Modulation Scheme for Fiber Optics Transmission: Introduction, Digital modulation, Analog modulation schemes, Multiplexing. Laser Systems: Introduction, Types of lasers: Solid state lasers, Gas lasers, Dye lasers, Lasers used in medical practice: Ruby laser, CO2 laser, Nd-YAG laser and related solid state laser
UNIT IV
Photo Detectors: Introduction, PIN photodiode, Avalanche photodiode, Photodiode parameters, Detector noise, Speed of response, SNR Laser -Tissue Interaction: Terminology: spectral band designations, Energy & power, Irradiant & radiant exposure, Fluency, Thermal diffi1sion fibers & contact tips, Types of laser-tissue interactions. Laser application in medical therapy.

Text Books
1. G. David Baxter, “Therapeutic Lasers -Theory and practice”, 1st Edition, Churchill Livingstone publications, 2000.
2. David H Shiney, Stephen and L. Trokel, “Medical Lasers and Their Safe Use”, 1st

Edition, Springer-Verlag publications, 1993.
3. S. K. Venkata Ram, “Biomedical Electronics & Instrumentation”, Galgotia Publications, 2008.

Reference Books

1. Katzer and Abraham, “Laser and Optical Fibers in Medicine”, Academic Press Publications, 2012.
2. A. M. Cherin, “An Introduction to Optical Fibers”, McGraw Hill Publications, 1982.

5.5.4.3. (III) BM -PE-3073 ANALYTICAL INSTRUMENTS AND TECHNIQUES 3-1-0=4

Subject Code: *BM -PE-3073*
Subject Name: *Analytical Instruments and Techniques*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. To learn the fundamentals of analytical techniques and instrumentation in biomedical engineering.
2. The students will gain knowledge to interpret results obtained from analytical instruments.
3. To understand the challenges and limitations of different analytical techniques.

Course Outcomes

1. Understand how to apply the basic principles of analytical techniques in handling the analytical instruments.
2. Understand the role of instrumentation in developing various analysis.
3. Understand the strengths, limitations, and use of the analytical techniques for problem solving .

UNIT I

Electrophoresis of nucleic acids and proteins, Capillary electrophoresis, Microchip electrophoresis. Principles of chromatography, Chromatographic performance parameters, High-performance liquid chromatography, Adsorption chromatography, Partition chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography, Affinity chromatography, Gas chromatography.

UNIT II

Ultraviolet and visible light spectroscopy, molecular fluorescence and phosphorescence, Fluorescence spectroscopy, Luminometry, Circular dichroism spectroscopy, Infrared and Raman spectroscopy, Surface plasmon resonance, x-ray photoelectron and Auger electron spectroscopy.

UNIT III

Nuclear magnetic resonance, Electron paramagnetic resonance, X-ray diffraction, Electron diffraction, Mass spectroscopy and detectors, ICP-MS, MALDI-TOF, Atomic spectroscopy, Zeta potential analysis, Dynamic light Scattering, Flow cytometry.

UNIT IV

The light microscope, Phase contrast, confocal microscope, Polarization microscopy, Electron microscopy, Fluorescence recovery after photobleaching (FRAP), Fluorescence resonance energy transfer (FRET), Fluorescence correlation spectroscopy (FCS), TEM & SEM, AFM, and STM, Differential scanning calorimetry (DSC), Thermogravimetric analysis (TGA), pH and ion-selective measurements, Voltammetry, Electrolytic conductance.

Text Books

1. R S Khandpur, Handbook of Analytical Instruments, McGraw Hill Education; Third edition (1 September 2015).

2. S. M Khopkar, Basic Concepts Of Analytical Chemistry, New Age International Private Limited; Fourth edition (1 January 2020).

Reference Books

1.GrinbergNelu (Author), Rodriguez Sonia, Ewing's Analytical Instrumentation Handbook, CRC Press; 4th edition (1 March 2019).
2. Gillian McMahon, Analytical Instrumentation: A Guide to Laboratory, Portable and Miniaturized Instruments, Wiley-Interscience; 1st edition (16 November 2007).

5.5.4.4. (IV) BM -PE-3074 BIO-TRANSPORT PROCESS 3-1-0=4

Subject Code: *BM– PE-3074*
Subject Name: *Bio-Transport Process*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. To understand the basic principles of fluid mechanics and mass transfer
2. To explore the applications of fluid mechanics and mass transfer in biomedical Engineering
3. To learn about the basics of pharmacokinetics.

Course Outcomes

1. The students will be able to understand basic principles of fluid mechanics and mass transfer.
2. The students will be able to understand applications of fluid mechanics and mass transfer in biomedical Engineering
3. The students will be able to understand the basics of pharmacokinetics.

UNIT I

Fluid Mechanics and Heat Transfer: Introduction to fluid mechanics, Bernoulli's equation, Heat Transport processes, Heat production in humans, heat transfer within the body.

UNIT II

Mass transfer, Blood and gaseous transport: Fick's law, Continuity equation, Transport through cell membranes, Membrane structure, composition and permeability, Active and Passive transport processes, Osmosis ,diffusion, Facilitated transport, Pinocytosis.

UNIT III

Compartment modelling: Pharmacokinetic models, one-compartment and two-compartment open models. Structure and gross operational features of the respiratory system,

UNIT IV

Transport in Human body: Gas transfer mechanism in lungs, Transport mechanisms in the kidney tubules, Haemodialysis: Types and methods

Text Books

1. Robert J. Roselli, Kenneth R. Diller "Biotransport: Principles and Applications", Springer, New York, 2011.
2. Ronald L. Fournier, "Basic transport phenomena in Biomedical Engineering", Taylor Francis, 2017.

Reference Books

1. Edwin N. Light foot, "Transport phenomena and living systems–Biomedical aspects of momentum and mass transport", John Wiley,1974.

5.5.5. BM-PC-LC-309 Biomechanics and Rehabilitation Engineering Laboratory 0-0-4 = 2

Subject Code: *BM-PC-LC-309*
Subject Name: *Biomechanics and Rehabilitation Laboratory*
No. of Hours Per Week: *Practicals-4*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Students will learn to apply biomechanical principles to the assessment and treatment of musculoskeletal injuries and disorders
2. Students will gain practical experience with state-of-the-art rehabilitation technologies and equipment, such as motion analysis systems, electromyography (EMG), and robotic-assisted devices.
3. Through critical analysis of scientific literature and case studies, students will learn to evaluate the effectiveness of biomechanically-based rehabilitation interventions

Course Outcomes

1. Upon completion of the course, students will demonstrate proficiency in conducting biomechanical assessments of human movement patterns. They will be able to accurately collect and analyze biomechanical data using advanced instrumentation and techniques, such as motion capture systems, force plates, and electromyography (EMG).
2. Students will be able to apply biomechanical principles to develop evidence-based rehabilitation strategies for individuals with musculoskeletal injuries and disorders
3. Through laboratory exercises, case studies, and research projects, students will develop critical thinking and problem-solving skills relevant to biomechanical rehabilitation practice

List of Experiments

1. EMG analysis through available equipments in laboratory.
2. Identification of different upper and lower extremity muscles in humans and their measurement.
3. Analysis of muscle activation during Sit-to-stand and Stand-to-Sit task from a chair at different heights.
4. EMG acquisition and analysis of lower limb muscles.
5. Angle measurement-using goniometer for upper extremity movements.
6. Angle measurement-using goniometer for lower extremity movements.
7. Analysis of Sit-to Stand movement from stationary chair employing EMG and Force plate.
8. Analysis of Stand-to Sit movement on a stationary chair employing EMG and Force plate
9. Force and torque measurement employing GAIT laboratory.
10. Evaluation of human gait cycle using GAIT laboratory.
11. Inverse dynamics of human gait.

Text Books

1. Sean P. Flanagan, Flanagan, “Biomechanics: A case-based Approach”, Jones and Bartlett Publishers, 2013.
2. Susan J Hall, “Basic Biomechanics”, 6th Edition, McGraw Hill, 2012.
3. D. Bhatia, “Stroke Rehabilitation”, ABS Publishers, Delhi,2016.

Reference Books

1. Prof. Ghista, “Biomechanics”, Private Publication UAF, 2009.
2. White and Puyator, “Biomechanics”, Private publication UAE, 2010.

5.5.6. BM-PC-LC-311 BIOMEDICAL SIGNAL PROCESSING LABORATORY 0-0-4=2

Subject Code:*BM-PC-LC-311*
Subject Name: *Biomedical Signal Processing Laboratory*
No. of Hours Per Week: *Practicals-4 hours*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten.*
Question to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Hands-on Experience with Signal Processing Techniques: Provide students with hands-on experience in applying signal processing techniques to analyze biomedical signals such as electrocardiograms (ECG), electromyograms (EMG), and electroencephalograms (EEG), aiming to extract relevant information and identify patterns associated with physiological phenomena.
2. Familiarization with Biomedical Signal Acquisition Systems: Familiarize students with biomedical signal acquisition systems, including sensors, amplifiers, and data acquisition devices, enabling them to understand the principles of signal acquisition, signal conditioning, and data conversion for various biomedical signals.
3. Development of Signal Processing Algorithms: Encourage students to develop signal processing algorithms and techniques tailored to specific biomedical signal processing applications, such as noise reduction, feature extraction, pattern recognition, and signal classification, using programming languages and software tools commonly used in biomedical engineering.

Course Outcomes

1. Proficiency in Signal Processing Techniques: Upon completion of the course, students will demonstrate proficiency in applying a range of signal processing techniques, including filtering, spectral analysis, time-frequency analysis, and nonlinear analysis, to analyze and interpret biomedical signals effectively.
2. Ability to Implement Signal Processing Algorithms: Students will gain the ability to implement and optimize signal processing algorithms for biomedical signal analysis using software tools such as MATLAB, Python, or specialized signal processing libraries, ensuring efficient and accurate processing of biomedical data.
3. Application of Signal Processing in Biomedical Research: By completing laboratory projects and assignments, students will apply signal processing techniques to real-world biomedical data sets, conduct experiments, analyze results, and draw conclusions relevant to biomedical engineering research and clinical applications.

List of Experiments

1. Sine wave generation using Computer programming
2. Designing an FIR filter using MATLAB or any suitable platform.
3. Designing an IIR filter using MATLAB or any suitable platform.
4. Fourier analysis of periodic signal.
5. Time frequency domain properties of different windows using MATLAB or any suitable platform.

6. Implementation of the Double-Precision Complex FFT for ECG signal.

7. Design of Notch filter for elimination of 50Hz from ECG signal.

8. EMG processing using MATLAB –Rectification and Signal Averaging.

9. Heart rate variability analysis employing ECG

10. Artifacts removal from ECG/EEG/EMG bio-signals.

Text Books

1. John G. Proakis and Dimitris G.Manolakis, “Digital Signal Processing, Algorithmsand Applications”, PHI of India Ltd., New Delhi, 3rd Edition, 2000.

2. Rangaraj.M.Rangayyan, “Biomedical signal processing: A Case Study”, IEEE press2002.

References Books

1. Sanjit K. Mitra, “Digital Signal Processing: A Computer Based Approach”, TataMcGraw-Hill, New Delhi, 1998.

2. A.V. Opponheim, A.S. Willsky and Nawab, “Signals and Systems”, 2nd Edition, PHI,2006

6.6. Sixth Semester Courses

6.6.1. BM-PC-302 TISSUE ENGINEERING AND REGENERATIVE MEDICINE 3-0-0 = 3

Subject Code: *BM – PC-302*
Subject Name: *Tissue Engineering and Regenerative Medicine*
No. of Hours Per Week: *Lectures-3,*
Marks Distribution: *Sessional Works = 30, End Semester Examination = 45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course objectives

1. Learn about the different types of biomaterials, scaffold fabrication techniques, and bioactive molecules used in tissue engineering approaches.
2. Investigate the potential of regenerative medicine approaches for treating various diseases and injuries, including musculoskeletal disorders, cardiovascular diseases, and neurodegenerative conditions.
3. Gain a comprehensive understanding of the principles underlying tissue engineering, including cell biology, biomaterials science, and scaffold design.

Course outcomes

1. Students will demonstrate a thorough understanding of the principles and concepts underlying tissue engineering, including cell biology, biomaterials science, and scaffold design.
2. Upon completion of the course, students will be proficient in analyzing and evaluating the applications of regenerative medicine in healthcare.
3. Students will develop problem-solving skills necessary for addressing complex challenges in tissue engineering and regenerative medicine.

UNIT I

Introduction: Basic principles and strategies of tissue engineering, Soft and hard tissue and its function, Vascularity and angiogenesis, Basic wound healing, Cell migration, concept of animal cell culture.
Media preparation, sterilization, Cell differentiation, Cell transfer, Cell storage and cell characterization, cell signaling Bioreactors design, Microfluidic in tissue engineering.

UNIT II

Artificial Organ and scaffolds: Engineering biomaterials for Artificial Organ, Degradable materials (collagen, silk and polylactic acid), Porosity, Mechanical strength, 3-D architecture, Printing and cell incorporation. Engineering tissues for replacing bone, Cartilage, Tendons, Ligaments, Skin and liver. Basic transplant, Immunology.

UNIT III

Regenerative Medicine: Introduction to stem cells and regenerative medicine, Embryonic stem cell in regenerative medicine, different tissue regeneration, ethical concern on regenerative medicine.

Text Books

1. Clemens van Blitterswijk, “Tissue Engineering”, Academic Press, 2008.

2. L Hench, J. Jones, “Biomaterials, Artificial Organs and Tissue Engineering”, 1st Edition Woodhead Publishing, 2005.

Reference Books

1. J. Endarle and Joseph Bronzino, “Introduction to Biomedical Engineering”, 3rd Edition, Academic press, 2011.
2.B. Palsson, J.A. Hubbell, R.Plonsey and J.D. Bronzino, “Tissue Engineering”, CRC- Taylor and Francis, 2003.

6.6.2. BM-PC-304 MEDICAL IMAGING AND IMAGE PROCESSING 3-1-0 = 4

Subject Code: BM-PC-304
Subject Name: *Medical Imaging and Image Processing*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Works = 40, End Semester Examination =60.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Three hours*

Course Objectives

1. To give knowledge regarding principle of digital imaging, image quality assessment and image processing.
2. To understand the workings of various radiological equipment, and associated imaging techniques of x-ray radiography and x-ray computed tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasound imaging.

Course Outcomes

1. Maintain biomedical imaging equipment
2. Students will understand specific applications of Biomedical imaging equipment aspects in field of radiology and to diagnose diseases.
3. Develop and implement algorithms for medical image processing.
4. Apply image processing algorithms for practical object segmentation applications

UNIT I: X-Ray and COMPUTED TOMOGRAPHY

Principles and production of X-rays**,** X-Ray Detectors, details of radiographic and fluoroscopic images in X-Ray systems. Principles of CT, evolution of CT machines – CT image formation, Artefacts in CT imaging.

UNIT II: ULTRASONICS and MAGNETIC RESONANCE IMAGING

Principle of MRI, Image acquisition in magnetic resonance imaging – T1, T2, proton density weighted images, spin-echo technique and spin relaxation technique, MR Angiography-Techniques
Ultrasonic –Physics of ultrasound – Principles of image formation – Capture and display, principles of A-Mode, B-Mode, M-Mode. Scan converters.

UNIT III: INTRODUCTION TO DIGITAL IMAGE PROCESSING

Image acquisition storage, processing, Visual perception: Structure of Human Eye, Image formation in human eye, brightness and contrast, Image enhancement: Image smoothing, point operators, contrast manipulation, histogram modification, frequency domain method, low pass and high pass filtering, median filtering, noise clipping image sharpening, spatial operators, Median filtering, frequency domain filtering, and algorithm implementation with applications.

UNIT IV: IMAGE TRANSFORMATIONS & SEGMENTATION

DFT and its properties, Image Restoration: Degradation Models and its restoration, Morphological operations, Colour image processing, Image Segmentation: Detection of discontinuity, point line and edge detection and boundary detection, Thresholding.

Text Books

1. R. C. Gonzales, R. E. Woods and S. L. Eddins, "Digital image processing using MATLAB", *Pearson Prentice Hall*, 2004.
2. M. Sonka, V. Hlavac, and R. Boyle, "Image Processing, Analysis, and Machine Vision", 4th ed. Boston, MA, USA: Cengage Learning, 2014.
3. J. Solem, "Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images" . O'Reilly Media, 2012.

Reference Book

1. R. S. Khandpur, "Handbook of biomedical Instrumentation", *TataMcGraw-Hill*, 2004.
2. W. K. Pratt, "Introduction to Digital Image Processing", *CRC*, 2013.
3. R. R., Paulsen, T. B. Moeslund, "Introduction to Medical Image Analysis" Germany: Springer International Publishing, 2020.

6.6.3. BM-PC-306 MICROPROCESSOR AND MICROCONTROLLER 2-1-0=3

Subject Code: *BM-PC-306*
Subject Name: *Microprocessor and Microcontroller*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Works = 30, End Semester Examination =45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives

1. Provide students with a comprehensive understanding of the architecture, components, and operation principles of microprocessors and microcontrollers commonly used in biomedical devices and systems.
2. Familiarize students with programming languages (e.g., assembly language, C) and interface techniques (e.g., GPIO, serial communication) used for microprocessor and microcontroller-based system development, enabling them to write and debug code for biomedical applications.
3. Introduce students to various biomedical applications of microprocessors and microcontrollers, including medical imaging, patient monitoring, diagnostic devices, and therapeutic systems, emphasizing their role in data acquisition, signal processing, control, and communication in healthcare settings.

Course Outcomes

1. Upon completion of the course, students will demonstrate proficiency in programming microprocessors and microcontrollers using assembly language and high-level languages such as C, enabling them to develop embedded software for biomedical devices and systems.
2. Students will gain the ability to design and interface microprocessor and microcontroller-based systems with various biomedical sensors, actuators, and peripherals, incorporating functionalities such as data acquisition, signal processing, user interface, and communication protocols.
3. By completing laboratory projects and assignments, students will apply their knowledge of microprocessors and microcontrollers to develop prototype biomedical devices or systems, demonstrating their ability to design, implement, test, and troubleshoot embedded solutions for healthcare applications.

UNIT I

8086/8088 Architecture addressing modes and instructions: instruction sets, addressing mode. Assembler directives and Advanced programming. Min and Max mode of operation. 8086 Programming, Interrupts and DOS interrupt 21H functions.

UNIT II

8155-Programmable I/O: 8255-Programmable Peripheral Interface; 8355-ROM; 8253 –Timer; 8251 – USART; 8257 – DMAC, 8259 – PIC. 8051 Architecture: Addressing modes and instructions, Programming of 8051. Applications of Microcontroller. Interfacing A/D converters with 8051 and 8086, data acquisition. Interfacing D/A converters, Waveform generation. Introduction to AVR.

UNIT III

8085 Programming: Stacks and subroutines, Counters, Time delays, Interrupts, Instruction cycle, Machine cycle, Timing diagrams. Memory Interfacing with 8085, Interfacing I/O, Memory mapped I/O and I/O mapped I/O. Interfacing A/D and D/A converters. Stepper motor interface with 8085.

Text Books

1. Ramesh S. Gaonkar, "Microprocessor architecture, Programming and Applications with 8085", 5th Edition, Penram International Publishing (India) Pvt. Ltd., 2002.

2. B. Ram, "Fundamentals of microprocessors and microcomputers", 3rd Edition, DhanpatRai Publication, 1989.

3. Douglas V.Hall, "Microprocessor and interfacing", 2nd Edition, McGraw Hill International, 2006.

Reference Books

1. Intel Corp., "The 8080/8085 Microprocessor Book: Intel marketing communications", Wiley Inter Science Publications, 1980.

2. Triebel and Singh, "The 8088 and 8086 Microprocessors", 4th Edition, Pearson Education, 2003.

6.6.4. BM-PC-LC-308 MEDICAL IMAGING AND IMAGE PROCESSING LABORATORY 0-0-4=2

Subject Code: *BM-PC-LC-308*
Subject Name: *Medical Imaging and Image Processing Laboratory*
No. of Hours Per Week: *Practicals-4.*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten*
Question to be answered**:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination:Three *Hours*

Course Objectives

1. To learn the fundamental concepts of Digital Image Processing.
2. To study basic medical image processing operations.
3. To understand medical image analysis algorithms.

Course Outcomes

1. Develop and implement algorithms for medical image processing.
2. Apply image processing algorithms for practical object segmentation applications

List of Experiments:-

1. Visit to hospital to observe working principle of medical imaging modality and analyze different images of Ultrasound, X-ray, Computed Tomography and Magnetic resonance imaging.
2. Write a program
    a) To draw white rectangle (200pixel X 100pixels) inside the black square (400 square pixels).
    b) To draw a black circle which have a diameter 200 pixels inside a 400 square pixel white box.
    c) To draw a English alphabet H.
    d) To draw three squares (300 pixel X 300pixel) cascaded color of red, green and blue.
3. Write a program to draw the histogram of provided image and on the basis of histogram perform threshold operation.
4. Write a program for histogram equalization and apply on given image.
5. Write a program for the edge detection using Roberts, prewitt, sobel edge detectors.
6. Write a program to convert RGB color model into HSV color model apply on given image.
7. Write a program to calculate different morphological features (Area, perimeter, major axis, minor axis) of an object in a given image.
8. Write a program to add salt and paper noise than apply median filter and comment on result.
9. Design a GUI and add following functionality
    a) A button for load an image
    b) A brightness adjustment bar
    c) A contrast adjustment bar
10. Write a program to count number of objects in given image and level objects
11. Segment vertebra column using suitable software and label different nodes.
12. Segment Liver using suitable software and write the appropriate strategy.

Text Books

1. R. C. Gonzales, R. E. Woods and S. L. Eddins, "Digital image processing using MATLAB", *Pearson Prentice Hall*, 2004.
2. A. K. Jain, "Fundamental of Image Processing", *Prentice Hall*, 1988.

6.6.5. BM-PC-LC-310 MICROPROCESSOR AND MICROCONTROLLER LABORATORY 0-0-4=2

Subject Code: *BM-PC-LC-310*
Subject Name: *Microprocessor and Microcontroller Laboratory*
No. of Hours Per Week: *Practicals-4*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Ten.*
Question to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Provide students with practical experience in working with microprocessor and microcontroller-based systems, including hardware interfacing, programming, and real-time operation, to develop a deep understanding of their functionalities and applications in biomedical engineering.
2. Foster the development of students' skills in designing, implementing, and testing embedded systems using microprocessors and microcontrollers, focusing on tasks such as sensor interfacing, data acquisition, signal processing, and control algorithm implementation relevant to biomedical applications.
3. Enhance students' problem-solving and troubleshooting abilities by engaging them in laboratory exercises and projects that require identifying and resolving hardware and software issues encountered during the design, testing, and debugging of microprocessor and microcontroller-based systems.

Course Outcomes

1. Upon completion of the course, students will demonstrate proficiency in programming microprocessors and microcontrollers using assembly language and high-level languages such as C, enabling them to develop embedded software for biomedical applications with efficient utilization of resources and real-time responsiveness.
2. Students will gain the ability to design, implement, and test embedded systems for biomedical applications, integrating microprocessors, microcontrollers, sensors, actuators, and communication interfaces to address specific requirements such as data acquisition, signal processing, and control in medical devices and systems.
3. Through collaborative laboratory projects and presentations, students will enhance their communication skills by effectively conveying their design methodologies, implementation strategies, experimental results, and conclusions to peers, fostering teamwork, and facilitating knowledge sharing within the biomedical engineering community.

List of Experiments:

1. Write an 8085 ALP to perform Binary /BCD addition between two bytes stored in consecutive / different location (Generated Carry).

2. Write an 8085 ALP to perform Binary / BCD subtraction between two bytes stored inconsecutive / different locations with sign of the result taken into account.

3. Write an 8085 ALP to generate of Fibonacci Series.

4. Write an 8085 ALP to reverse a string .The string is either a binary byte or a bunch of data bytes stored in consecutive locations.

5. Write an 8085 ALP to arrange the bytes (stored in consecutive locations) in sorted order either ascending or descending order.

6. Write an 8085 ALP to verify the incoming and outgoing data using LEDS and a PPI chip.

7. Write an 8085 ALP to generate a square wave of a certain frequency using PPI chip and a CRO display.

8. Write an 8086 ALP to find the largest number from an array of 16-bit numbers stored equentially in memory location.

9. Write an 8086 ALP to convert a given word into its decimal equivalent.

10. Write an 8086 ALP to find out whether a given byte is present in the string or not.

11. Write a 8086 ALP program to open a new file kmb.dat in the current directory anddrive if it is successfully opened. Write 200H Bytes of data into it from a data blocknamed BLOCK. Display a message if the file is not opened successfully.

12. Employ 8051 as controller for monitoring devices.

13. Employ 8051 to perform Boolean operations.

14. Write an ALP to interface a keyboard with 8086 microprocessor using PPI chips.

15. Write an ALP to interface a stepper motor with 8085 microprocessor using PPI chips.

Text Books

1. Ramesh S. Gaonkar, “Microprocessor architecture, programming and applicationswith 8085”, 5th Edition, Penram International Publishing (India) Pvt. Ltd., 2002.

2. B. Ram, “Fundamentals of microprocessors and microcomputers”, 3rd Edition,DhanpatRai Publication, 1989.

Reference Books

1. Triebel and Singh, “The 8088 and 8086 Microprocessors”, 4th Edition, PearsonEducation, 2003.

2. Douglas V.Hall, “Microprocessor and interfacing”, 2nd Edition, McGraw HillInternational, 2006.

6.6.4. BM-OE-308E: OPEN ELECTIVE COURSES – I

6.6.4.1. (I) BM-OE-3081 NANOTECHNOLOGY IN HEALTHCARE 2-1-0=3

Subject Code: *BM OE- 3081*
Subject Name: *Nanotechnology in Healthcare*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Works = 30, End Semester Examination =45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives

1. To understand the basics of Nanobiotechnology.
2. To explore the applications of Nanotechnology in biomedical Engineering.
3. To learn about the applications of Nanomedicine.

Course Outcomes

1. The students will be able to understand basic principles of Nanobiotechnology.
2. The students will be able to understand applications of Nanomedicine in drug delivery, Sensing and imaging.

UNIT I

Introduction to BioNanotechnology: Cellular nanostructures, Self-assembly of colloidal nanostructures of biological relevance.

UNIT II

Synthesis and characterization of nanoparticles: Lipid-based nanoparticles, Polymeric nanoparticles, Carbon-based nanotubes, Smartcapsules, metal nanoparticles. Nanoparticles for drug delivery: Cancer therapies, hyperthermia, photothermal therapy, Tissue engineering and cancer therapy, Environmental and safety aspects of bio-nanotechnology.

UNIT-III

Nanoparticles for sensing and imaging: Biosensors, Quantum dots, metal nanoparticles for biosensing and imaging applications.

Texts Books

1. K. Haghi, Mathew Sebastian, Neethu Ninan (Eds.) "*Nanomedicine and Drug Delivery", CRC Press, 2012.*
2. David S. Goodsell,"Bionanotechnology:LessonsfromNature",Wiley-Liss,2004.
3. M Gogoi, S. Patra, D. Kundu," Nanobiosensors for point-of-care medical diagnostics", Springer Nature, 2023.

Reference Books

1.Kenneth J .Klabunde,"NanoscaleMaterialsinChemistry",JohnWileyandSons,Inc.,2001.

6.6.4.2. (II) BM-OE-3082 BIOLOGICAL CONTROL SYSTEM 2-1-0=3

Subject Code: *BM OE- 3082*
Subject Name: *Biological Control System*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Works = 30, End Semester Examination =45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives

1. Understanding the fundamental principles of control systems and their applications in biological systems.
2. Exploring various biological control mechanisms found in organisms, such as homeostasis, feedback loops, and neural regulation.
3. Learning mathematical modeling techniques to describe and analyze biological control systems.
4. Studying the integration of engineering concepts with biology to design and manipulate biological systems.

Course Outcomes

1. The course outcome for Biological Control Systems centres on providing students with a comprehensive understanding of how living organisms regulate and maintain stability within their internal environments.
2. Through this study, students gain insights into the intricate mechanisms and principles governing biological control systems, including feedback loops, homeostasis, and neural regulation. This knowledge equips them to analyze and predict the behaviors of biological systems, utilizing concepts from control theory
3. Furthermore, students explore the interdisciplinary nature of biological control systems, recognizing the integration of biology and engineering principles.
4. Ultimately, the course aims to foster critical thinking skills, preparing students to tackle complex challenges in fields such as healthcare, biotechnology, and environmental science, and empowering them for further studies or careers in bioengineering, biomedical research, or related disciplines.

UNIT I

Modeling of Systems: Terminology and the basic structure of control system, Example of a closed loop system, Transfer functions, modeling of electrical systems, Translational, and rotational mechanical systems, and electro-mechanical systems, Block diagram and signal flow graph representation of systems, Conversion of the block diagram to signal flow graph, Reduction of the block diagram and signal flow graph. Time Response and Stability Analysis: Step and impulse responses of first-order and second-order systems, Determination of time domain specifications of first and second-order systems from their output responses,

UNIT II

Definition of steady-state error constants and their computations. Definition of stability, Routh- Hurwitz criteria of stability, Root locus technique, Construction of root locus and study of stability, Definition of dominant poles and relative stability. Frequency Response Analysis: Frequency response, NY Quist stability criterion, NY Quist plot and determination of closed-loop stability, Definition of gain margin and phase margin, Bode plot, Determination of gain margin and phase margin using Bode plot, Use of Nichol's chart to compute response frequency and bandwidth.

UNIT III

Physiological Control System: Introduction to Physiological Control system with example, Difference between engineering and physiological control systems, Generalized system properties, Models with combination of system elements, Linear models of physiological systems- Examples, Introduction to simulation.

Text Books

1. Michael C K Khoo, “Physiological Control Systems”, IEEE Press, Prentice Hall of India, 2001.
2. M. Gopal “Control Systems Principles and Design”, Tata McGraw Hill, 2002.
3. John Enderle Susan Blanchard, Joseph Bronzino “Introduction to Biomedical Engineering”, second edition, Academic Press, 2005.

Reference Books

1. Richard C. Dorf, Robert H. Bishop, “Modern control systems”, Pearson, 2004.
2. L. Stark, “Neurological Control System”, Plenum Press, 1968.

6.6.4.3. (III) BM-OE-3083 MOLECULAR DIAGNOSTICS AND THERAPEUTICS 2-1-0=3

Subject Code: *BM-OE-3083*
Subject Name: *Molecular Diagnostics and Therapeutics*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Works = 30, End Semester Examination =45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives

1. To understand the principles of various diagnostics and therapeutics
2. To apply the knowledge to improve the methods of clinical diagnosis and treatment

Course Outcomes

1. The students will be able to understand Safety in the Clinical Laboratory, Collection and Processing Laboratory Specimens and quality assurance.
2. The students will be able to describe the principles of chemistry involved in various diagnostics.
3. The students will be able to describe the principles of immunotechnology and design involved in various serological tests.
4. The students will be able to describe various existing and futuristic molecular biology based diagnostics and therapeutics.
5. The students would know the principles of radiations and its applications in both diagnostics and therapeutics.

UNIT I

Introduction to Clinical Laboratory Science, Safety in the Clinical Laboratory, Collection and Processing Laboratory Specimens, Quality Assurance in the Clinical Laboratory, Automation in the Clinical Laboratory. Use of the Microscope, Fixation, Decalcification, Dehydration, Impregnation and Embedding Techniques, Biological Staining, Staining Procedures, Cytological Techniques, Clinical Chemistry, Principles of biochemical tests, Sterilization,

UNIT II

Serological tests, antigen-antibody test kits, PCR, RT-PCR, Forensic tests, ELISA and Chemiluminescence assays, Immunofluorescence assay, Point of Care diagnostics. Rapid diagnostic tests and kits, Electrochemiluminescence, CRISPR Technology. DNA Sequencing, DNA fingerprinting,

UNIT III

Definition and classification of radioisotopes, Regulatory and safety considerations in the use of radioisotopes, Methods of radioisotope production, Radiopharmaceutical formulation and labeling techniques, Principles of nuclear imaging techniques, Principles of radiation therapy and dosimetry, External beam radiation therapy vs. internal radiation therapy, Biopharmaceuticals and Gene Therapy, Pharmaceuticals, biologics and biopharmaceuticals, drug development process, vaccines and adjuvants, and Nucleic acid- and cell-based therapeutics. Immunopharmaceuticals, CAR T cell therapy,

Text Books

1. Darshan P. Godkar and Praful B. Godkar, *Textbook of Medical Laboratory Technology Vol 1 & 2,*,Bhalani Publishing House , 3rd edition,2014.
2. Kanai L Mukherjee and Swarajit Ghosh, *Medical Laboratory Technology: Procedure Manual for Routine Diagnostic Tests,* McGraw Hill Education (India) Private Limited , 2nd edition,2010.

Reference Books

1. Robert R. Harr, *Medical Laboratory Science Review,* F.A. Davis Company; Fourth edition (October 11, 2012).
2. Mary Louise Turgeon, Linne & Ringsrud's, *Clinical Laboratory Science: Concepts, Procedures, and Clinical Applications,* Mosby, 7th Edition, 2015.

6.6.4.4. BM-OE-3084 MOOCS as per NEHU norms

7.7. Seventh Semester Courses

7.7.1. BM-PC-401 ENTREPRENEURSHIP AND IPR 3-1-0=4

Subject Code: *BM-PC-401*
Subject Name: *Entrepreneur and IPR*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Gain a comprehensive understanding of various forms of intellectual property rights including patents, trademarks, copyrights, and trade secrets.
2. Cultivate an entrepreneurial mindset that emphasizes creativity, innovation, and strategic thinking in leveraging intellectual property for business success.
3. Acquire practical knowledge and skills related to identifying, protecting, and managing intellectual property assets within entrepreneurial contexts.

Course Outcomes

1. Students will demonstrate a comprehensive understanding of the relationship between entrepreneurship and intellectual property rights (IPR), including patents, trademarks, copyrights, and trade secrets.
2. Students will cultivate an entrepreneurial mindset with regard to intellectual property, recognizing opportunities for innovation, creativity, and value creation.

UNIT I

Entrepreneurship: Definition of Entrepreneurship, Innovations, Start-ups and its types, Different Entrepreneurial initiatives in healthcare, Healthcare Start-up, product design and development strategies studies, SWOC analysis in the understanding the healthcare sector.

UNITII

Innovation in Healthcare: Innovation in healthcare and diagnostics, introduction to adaptive clinical trial design, Biosensor design and technology, overview of pharmaceutical and material industry.

UNIT- III

IPR I: Intellectual property, definition, types, rights and functions, patents, trademark, software design, industrial designs, semi-conductor and integrated circuits layout design, grant of patent in India, authority and procedure, patent forms, surrender and revocation of patents and compulsory licensing, acquisition of inventions by the Government.

UNIT- IV

IPR II: Contents of draft application for patents, Drafting patent specification and claims, WTO and drafting patent specification and claims, IPR infringement and piracy under Indian Laws.

Text Books

1. Vinod V. Sople, "Managing Intellectual Property: The Strategic Imperative", PHI, 2006.
2. B. L. Wadehra, "Law Relating to Intellectual Property", Universal Law Publishing, 2009.
3.Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha, Entrepreneurship, 11th Edition, Mcgraw Hill, 2022.

Reference Books

1. Kotler, Keller, Koshy, Jha, "Marketing Management-A South Asian Perspective", Pearson Ltd., 2009.
2. Luthans, Fred, "Organizational Behaviour", TMH, New Delhi, 2003.

BM-PE-403E: PROGRAM ELECTIVE- II

7.7.1.1. (I)BM-PE-4031 SPORTS BIOMECHANICS AND REHABILITATION 3-1-0=4

Subject Code:*BM-PE-4031*
Subject Name: *Sports Biomechanics and Rehabilitation*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*

Course objectives

1. Gain a comprehensive understanding of the principles of biomechanics as applied to sports, including kinematics, kinetics, and mechanical principles.
2. Explore the biomechanical factors influencing sports performance, such as force production, motion analysis, and energy transfer.
3. Learn to apply biomechanical principles to analyze and optimize athletic techniques, equipment design, and training interventions for enhanced sports performance and injury prevention.

Course outcomes

1. Upon completion of the course, students will demonstrate proficiency in understanding the principles of sports biomechanics, including kinematics, kinetics, and anatomical motion analysis.
2. They will be able to analyze and interpret movement patterns, forces, and mechanics associated with sports performance and injury mechanisms.
3. Through theoretical lectures, laboratory sessions, and practical exercises, students will develop the skills necessary to apply biomechanical principles to analyze and optimize athletic performance, prevent injuries, and design effective rehabilitation protocols.

UNIT I

Introduction: Introduction to Kinesiology and Sports Biomechanics, Internal and external Biomechanics, Movement patterns – the essence of sports biomechanics.

UNIT II

Major Muscles – their Location & Action: Origin, Insertion and action of muscles: Pectoralis major and minor, Deltoid, Biceps, Triceps (Anterior and Posterior), Trapezius, Serratus, Sartorius, Rectus femoris, Abdominis, Quadriceps, Hamstring, Gastrocnemius; Geometry of motion.

UNIT III

Lower and upper limb biomechanics: Detail biomechanics of Lower Limb Activities (e.g., Running, Jumping) and upper limb (e.g., Throwing, Batting); Biomechanics and Ergonomics in Sports Equipment- Shoe Design and Running Mechanics; Equipment Design and Injury Prevention; Common Sports Injuries and Biomechanical Causes.

UNIT IV

Sports Rehabilitation: Upper and lower limb rehabilitation types, Common Sports Injuries and Biomechanical Causes; Gait Abnormalities and Rehabilitation Strategies; Rehabilitation Techniques and Program Design.

Text Books

1. Peter M, McGimis. Biomechanics of Sport and Exercise. 4th Edition, Human Kinetics Publications. ISBN-13 : 978-1492571407, 2020.

2. Dinesh Bhatia, 2021, Modern Technological Intervention Advancements for the Physically Challenged and Disabled Population, Cambridge Scholars Publishing, U.K

3. Nihat Ozkaya, Dawn Leger, David Goldsheyder and Margareta Nordin. Fundamentals of Biomechanics: Equilibrium, Motion and Deformation. 4th Edition, Springer, ISBN 978-3-319- 44737-7, 2018.

Reference Books

1. Duane Knudson. Fundamentals of Biomechanics. 2nd Edition, Springer, ISBN 978-0- 387-49311-4, 2007.

2. David A. Winter, Biomechanics and Motor Control of Human Movement. 4th Edition, John Wiley & Sons, ISBN 978-0-470-39818-0, 2009.

3. Roger Bartlett. Introduction to Sports Biomechanics: Analysing Human Movement Patterns. 2nd Edition, Taylor & Francis, ISBN 0-203-46202-5, 2007.

7.7.1.2. BM-PE-4032 ROBOTICS FOR HEALTHCARE 3-1-0 = 4

Subject Code: *BM-PE-4032*
Subject Name: *Robotics for Healthcare*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course Objectives

1. Understanding the fundamental principles of robotics, including kinematics, dynamics, and control.
2. Familiarizing with various types of robots, actuators, sensors, and their applications.
3. Learning programming languages and software tools commonly used in robotics, such as ROS (Robot Operating System).
4. Exploring different robotic architectures and control strategies, including teleoperation, autonomy, and human-robot interaction.

Course Outcomes

1. The course outcome for Robotics typically aims to equip students with the knowledge and skills necessary to understand, design, and implement robotic systems effectively. This includes proficiency in robot kinematics, dynamics, and control, as well as the ability to apply these concepts to solve real-world problems.

2. Ultimately, students should be prepared to contribute to advancements in robotics technology and pursue careers in fields such as manufacturing, healthcare, automation, and research.

UNIT I

Introduction: Definition, Classification, Robot Components, Degree of Freedom, Mobile robots, Robot Characteristics, Robot Workspace, Robot programming. Application of Robots. Sensors and Actuators: Internal Sensors, External Sensors, Contact Sensors, Bumpers, Infrared Sensors, Sonar, Radar, Laser Range Finders, Non-visual Sensors, and Algorithms. DC Motors, Gearing and Efficiency, RC Servo Motors, Brushless DC Motor, Stepping Motors, Motor Control.

UNIT II

Robot Kinematics: Rotation matrix, Euler angles, Quaternions, Homogeneous transformation, DH Convention, Typical examples, Joint space, Operational space, forward and Inverse Kinematics problem. Robot Statics: Geometric Jacobian, Jacobian Computation, kinematic singularities, Analysis of redundancy, Analytical Jacobian, Inverse Kinematics algorithms, Statics, Kineto-static duality, Velocity and force transformations.

UNIT III

Robot Dynamics: Lagrange formulation, Computation of kinetic and potential energies, Dynamical model of simple manipulator structures, Direct dynamics and inverse dynamics, Operational space dynamic model. Trajectory Planning: Robot workspace analysis, joint space trajectories, path and trajectory planning of a robot.

UNIT IV

Motion Control: The control problem, Joint space control, Decentralized control, Computed torque feed-forward control, Centralized control, PD Control with gravity compensation, Inverse dynamics control, and Operational space control.

Text Books

1. Craig, J.J., Introduction to Robotics: Mechanics and Control, 3rd Edition, Addison-Wesley, Reading, MA, 1989.
2. L. Sciavicco, B. Siciliano, Modeling and Control of Robot Manipulators, Springer, 2002.
3. Angeles, J., Fundamentals of Robotic Mechanical Systems, Springer-Verlag, New York, NY, 1997.

Reference Books

1. Fu, Gonzales, and Lee, Robotics: Control, Sensing, Vision, and Intelligence, McGraw-Hill, 1987.
2. Shames, I.H, "Engineering Mechanics-Statics and Dynamics", 4/e, Prentice-Hall of India Pvt. Ltd., 2005.

7.7.2.3.(III) BM-PE-4033 BIO-MEMS

3-1-0=4

Subject Code: *BM–PE-4033*
Subject Name: *Bio-MEMS*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works=40,End Semester Examination=60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course objectives

1. Gain a comprehensive understanding of BioMEMs (Biomedical Microelectromechanical Systems), including their design principles, fabrication techniques, and applications in healthcare.

2. Explore the interdisciplinary nature of BioMEMs, integrating principles from biology, microfabrication, materials science, and electronics.

3. Learn about the unique challenges and considerations involved in designing and implementing BioMEMs devices for biomedical applications, such as biocompatibility, miniaturization, and integration with biological systems.

Course outcomes

1. Upon completion of the course, students will demonstrate mastery of the principles and concepts underlying BioMEMs (Biomedical Microelectromechanical Systems), including their design, fabrication, and integration with biological systems.

2. They will be able to explain the interdisciplinary nature of BioMEMs, integrating principles from biology, microfabrication, materials science, and electronics to address biomedical challenges.

3. Through theoretical lectures, practical exercises, and case studies, students will develop a deep understanding of BioMEMs principles, enabling them to analyze, design, and evaluate BioMEMs devices and systems for diverse biomedical applications.

UNIT I

MEMS and Microsystems: Photolithography: Mask design; Wet and dry etching; Thin film deposition and growth, Electroplating, Moulding, LIGA, Bonding and sacrificial processes, Polymer processing and rapid prototyping.

UNIT II

MEMSANDMicrofluidicSystem:BiomaterialsandBiocompatibilityIssues:Microfluidics,Micrototalanalysissystem(μTAS):Fluidcontrolcomponents,μ-TAS:Samplehandling,μ-TAS:Separationcomponents,μ-TAS:Detection.

UNITIII

Cell Hand ling and Characterization: Systems for PCR, Polynucleotide arrays and genetic screening.

UNIT IV

Microsensors and Microactuators: Biosensors, Miniature Biosensors, Biosensors arrays and implantable devices.

Text Books

1. Manz and H. Becker, "Microsystem Technology in Chemistry and Life Sciences", Springer-Verlag, NewYork,1999.
2. Albert Folch, "Introduction to BioMEMS",1st Edition, CRC Press,2012.

Reference Book

1. Cooney David, "Biomedical Engineering Principles",Volume1,Marcel Decker,1976.

7.7.1.3. BM-PE-4033 MOOCS as per NEHU Norms

7.7.3. BM-PE-405X : PROGRAM ELECTIVE-III

7.7.3.1. (I) BM-PE-4051 HOSPITAL ADMINISTRATION AND MANAGEMENT

3-1-0=4

Subject Code: *BM-PE-II-405*1
Subject Name: *Hospital Administration and Management*
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Three Hours*

Course Objectives

1. To obtain the knowledge about the basic planning and organization of hospitals.
2. To study about the clinical and administrative services.
3. To impart knowledge on designing of hospital services.

Course Outcomes

1. Understand the organisational structure and duties at each governing level of a hospital.
2. Learn about the various departments in the hospital.
3. Learn the functions and duties of the Biomedical Engineering department.
4. Know about the importance of safety rules, security protocols and disaster management in a hospital.

UNIT I

Organisation and Planning of the Hospital: Organisational structure: Governance, Duties and responsibilities of the governing board, Management structure: Duties, responsibilities and functions of the CEO, Hospital information System: Benefits, Organisation, Layout, Survey, Financial planning, Equipment planning.

UNIT II

Medical, Auxiliary Services and Nursing Services: Emergency services, Clinical laboratories, Radiological services, Diagnostic radiology, Radiation therapy department, Nuclear Medicine, Surgical Department, , CATH lab, OT: Design and related equipment. General nursing unit, Central Nurse Station, Intensive Care Unit(ICU), New-born nurseries. Electrical system, Air conditioning services, Centralised gas system, Communication systems, Transportation, CSSD.

UNIT III

Engineering and Biomedical Engineering Department: Engineering department: Functions, Location, Design, Organization, Maintenance management. Biomedical Engineering department: Functions, Designs, Space facilities, Utilities, Hospital wiring system.

UNIT IV

Safety and Security in the Hospital: Hospital safety rules, Security and loss prevention, Fire safety, Bomb threat, Alarm systems, Disaster and Disaster preparedness plan, Safety codes for electrical and medical equipments, Medical standards for hospitals and equipment.

Text Books

1. Dinesh Bhatia, Prabhat Chaudhari, Bhupinder Chaudhary, Sushman Sharma, Kunaal Dhingra, 2022 "A guide to Hospital Administration and Planning", Springer Nature, Switzerland
2. G.B. Kunder and Gopinath, "Hospital Planning, Design and Management", Tata McGraw Hill. year

3. S. L. Goel and R. Kumar, "Principles of Hospital Administration and Planning", Deep and Deep Publications.
B. Feinberg, "Applied Clinical Engineering", Prentice Hall. Year
4. J. Webster and A. Cook, "Clinical Engineering Principles and Practices", Prentice Hall. year
H. D. Banta and B. Luce, "Health Care Technology and its Assessment", Oxford Medical Publications. year

Reference Books

1. C. W. Nelson, "Operations Management in the Health Services: Planning Restructuring and Control", Elsevier Science Ltd. year
2. J. S. Rakich, "Hospital Organisation and Management", S.P. Medical and Science Book Publication. year

7.7.3.2. (II) BM-PE-4052 BIOMIMETIC TECHNOLOGY 3-1-0=4

Subject Code: *BM-PE-4052*
Subject Name Biomimetic Technology
No. of Hours Per Week: *Lectures-3, Tutorial-1.*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Three Hours*

Course Objectives
1. Understand the fundamental principles of biomimicry and its applications in technology.
2. To study the nanoscale biological molecules and their applications.
3. Analyze biological systems and processes for inspiration in technological design.
4. Evaluate successful biomimetic technologies across different domains.
5. Develop practical skills in applying biomimicry concepts to solve engineering and design challenges.

Course Outcomes
1. Gain understanding of biomimetic principles and methods in Biomimetics.
2. Will be able to apply biomimetic approaches to solve engineering problems.
3. Develop skills in biomimetic design methodologies.
4. Foster critical thinking in addressing healthcare challenges through biomimicry.

UNIT I
Introduction to Biomimetics, Comprehend the structure and function of various nanoscale biomolecules, DNA-protein nanostructures, Self-assembled structure in a biological system, Nanocarrier, Biological nanomachines, Inventions inspired by nature for biomedical applications., Biomineralization, Bio-mechanisms of Swimming and Flying. Biomimetic design process: observe, abstract, emulate, and evaluate (OAEV).

UNIT II
Biomimetic Concepts to Applications in chemical synthesis, Supramolecular Chemistry of Biomimetic Systems, Genetic approaches to programmed assembly, Nucleic acid based nanodevices, DNA nanotechnology, RNA nanotechnology, DNA templated electronics, DNA nanostructures for mechanics and computing, Biomimetic nanopores, Biomimetic Membranes.

UNIT III
Biomimetic approaches to biomaterials design and fabrication, Biomimetic materials and composites, biomimetic fabrication, Synthesis of nanomaterials- Heterogeneous and Homogeneous nucleation. Biological and biomimetic adhesives, Biomimetics in tissue engineering and drug delivery systems, artificial retina and kidney, organ on a chip,

UNIT IV
Biomimetic surfaces, surface modification techniques, Surfaces and interfaces of biomimetic superhydrophobic materials, biomolecular motors, biomimetic robots:myomorphic actuators, Biomimetic Sensor Technology, neuromorphic sensors, Bio-inspired algorithms for medical data analysis and treatment optimization Biomimetic Neural Learning, Biomimetic Electronics as Neural Prostheses, Case studies of biomimetic solutions,

Text Books

1. Brian Clegg, Biomimetics: How Lessons from Nature can Transform Technology, Icon Books (20 July 2023)
2. Sandy B. Primrose, Biomimetics: Nature-Inspired Design and Innovation,Wiley-Blackwell; 1st edition (8 October 2020)

Reference Books

1.Yoseph Bar-Cohen, Biomimetics: Nature-Based Innovation, CRC Press Inc; 1st edition (21 September 2011)

2. Ziyad S. Haidar, Biomimetics: Bridging the Gap, Intech Open (25 January 2023)

7.7.3.3. (III) BM-PE-405HEALTHCARE INFORMATICS AND TELEMEDICINE 3-1-0 = 4

Subject Code: *BM-PE-4053*
Subject Name: *Healthcare Informatics and Telemedicine*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Course objectives

1. Gain a comprehensive understanding of healthcare information systems, including electronic health records (EHRs), health information exchange (HIE), and clinical decision support systems (CDSS).
2. Learn about the legal, ethical, and regulatory considerations surrounding healthcare informatics, including patient privacy, data security, and compliance with healthcare standards and regulations.
3. Acquire practical knowledge and skills in designing, implementing, and evaluating healthcare informatics and telemedicine systems.

Course outcomes

1. They will be able to analyze the role of information technology in healthcare delivery, administration, and management, and understand the legal, ethical, and regulatory considerations surrounding healthcare informatics.
2. Upon completing the course, students will possess the ability to design, implement, and evaluate healthcare informatics and telemedicine solutions effectively.
3. They will be able to analyze the role of information technology in healthcare delivery, administration, and management, and understand the legal, ethical, and regulatory considerations surrounding healthcare informatics.

UNIT I

Introduction - Structure of Healthcare Informatics –Internet and Medicine, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, CIS, e-health services, Health Informatics – Medical Informatics, Bioinformatics.

UNIT II

Data Compression and Safety- Introduction, Classification of data, Database Management System (DBMS), History taking by computer, Dialogue with the computer, Components and functionality of EPR and CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients, Security issues and its prevention.

UNIT III

Computers in medical imaging: Role of computers in medical imaging, Computers in medical decision making, Expert system- General model of CMD, Neurocomputers and Artificial Neural Networks with applications, Computer assisted surgery v/s Robotic Surgery with applications, IoT in medical field and remote surgery.

UNIT IV

Telemedicine and Artificial Intelligence: Fundamental concepts, Significance, Principle, functional blocks of Telemetry and Telecontrol system, Methods of telemetry, State of art- Telemetry standards., Medical Peripheral devices, Introduction to Artificial neuron and neural networks (ANN), types of learning, Introduction and foundation of Fuzzy systems, Application of AI in biomedical engineering.

Text Books

1. R. D. Lele, "Computers in medicine progress in medical informatics", Tata McGraw Hill Publishing computers Ltd, New Delhi, 2005.
2. D. Bhatia, "Medical Informatics", Prentice Hall of India Publication, 2015.
3. Sudip Paul, Dinesh Bhatia, 2020, "Smart healthcare for disease diagnosis and prevention", Elsevier Publisher.

Reference Books

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003 New Delhi, 2003.

7.7.3.4. (IV) BM-PE-4054 MOOCS as per NEHU Norms

7.7.4. BM-OE-407X: OPEN ELECTIVE COURSES-II

7.7.4.1. (I) BM-OE-4071 MEDICAL DEVICE STANDARDS AND REGULATIONS

2-1-0=3

Subject Code: *BM- OE- 4071*
Subject Name: *Medical Device Standards and Regulations*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Works = 30, End Semester Examination =45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course objectives

1. Gain a comprehensive understanding of the regulatory landscape governing medical devices, including key regulatory agencies, standards organizations, and global regulatory frameworks.

2. Explore the purpose and significance of medical device regulations in ensuring product safety, efficacy, and quality, and protecting public health.

3. Learn about the regulatory pathways for medical device approval and clearance, including the requirements for premarket notification, premarket approval, and CE marking.

4. Familiarize oneself with international standards and guidelines applicable to medical devices, such as ISO 13485, ISO 14971, and FDA Quality System Regulation (21 CFR Part 820).

Course outcomes

1. Upon completion of the course, students will demonstrate a comprehensive understanding of medical device standards and regulatory frameworks applicable in the healthcare industry.

2. They will be able to identify and explain key standards organizations and regulatory agencies responsible for setting guidelines and enforcing regulations governing medical devices.

3. Through theoretical lectures, case studies, and practical exercises, students will gain insight into the purpose, scope, and significance of medical device standards and regulations in ensuring product quality, safety, and efficacy.

UNIT I
Medical Device Guidelines: Medical Devices, guidelines, regulations and safety, Role of Central Drugs Standard Control Organization (CDSCO), Quality Management system in manufacturing of medical devices.

UNIT II
Regulation of medical devices: Classification of medical devices, Essential principles for manufacturing of medical devices, product standards for medical devices, Laboratory registration for carrying out testing of medical devices.
Medical device standards: ISO standards, Medical Device Rules (MDR), 2017, Authorities, Officers and Bodies for following MDR, 2017, Manufacturing of medical devices for sale or distribution

UNIT III

Import and manufacturing of Medical Devices: Guidelines for the Import of Medical Devices, labelling of medical devices, clinical and performance investigation of medical devices, guidelines for manufacturing and sale of medical devices, Duties and role of Medical Officer, Medical Device Testing Officer.

Textbooks

1. M. R. Jaffe and R. S. Reifman, "Medical Device Software Verification, Validation, and Compliance," 1st ed. Boca Raton, FL, USA: CRC Press, 2010.
2. M. R. Neuman, "Biomedical Sensors and Instruments," 2nd ed. Boca Raton, FL, USA: CRC Press, 2010.

Reference Books

1. A. T. Reilly, "FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics," 4th ed. Boca Raton, FL, USA: CRC Press, 2008.
2. F. H. Lewis, "Handbook of Human Factors and Ergonomics in Health Care and Patient Safety," 2nd ed. Boca Raton, FL, USA: CRC Press, 2012.

7.7.4.2. BM- OE- 4072 MICROFLUIDICS 2-1-0=3

Subject Code: *BM-OE-4072*
Subject Name: *Microfluidics*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Works = 30, End Semester Examination =45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives

1. Understanding of Microfluidics Fundamentals:
2. Proficiency in Microfluidic Device Fabrication:
3. Competence in Fluid Flow Analysis:

Course outcomes

1. To understand the principles of microfluidics
2. To understand the device fabrication
3. Student will learn fluid flow analysis in microfluidic system

UNIT -I

Introduction to Microfluidics: Definition and scope of microfluidics, background, application in various fields, Behavior of fluids at the microscale, Scaling laws and Reynolds number, Surface tension and wettability, Capillary action and flow regimes

UNIT -II

Microfluidic Device Fabrication: Fabrication techniques: photolithography, soft lithography, micro-machining, 3D printing, Material selection considerations, Microfluidic chip design and layout, Governing equations: Navier-Stokes equations, continuity equation, Laminar flow vs. turbulent flow, Pressure-driven flow, electrokinetic flow, and other driving mechanisms, Flow control and manipulation techniques

UNIT -III

Microfluidic Actuators and Sensors: Introduction to microfluidic actuators: pneumatic, hydraulic, and thermal actuators, Flow sensors: pressure sensors, flow rate sensors, Detection techniques: optical detection, electrochemical detection, mass spectrometry. Applications of Microfluidics: Biomedical applications: lab-on-a-chip, point-of-care diagnostics, drug delivery systems, Chemical analysis and synthesis: microreactors, separation techniques, emerging applications in nanotechnology and materials science

Text Books

1. Manz and H. Becker, “Microsystem Technology in Chemistry and Life Sciences”, Springer- Verlag, New York, 1999.
2. Albert Folch, “Introduction to BioMEMS”, 1st Edition, CRC Press, 2012.

Reference Books

1. Cooney David, “Biomedical Engineering Principles”, Volume 1, Marcel Decker, 1976.
2. Dane E Karne & Michael C Raymer, “Fundamental concepts of Bioinformatics”, Pearsons Education, 2006.

7.7.4.4. (IV) BM-PE-4074 MOOCS as per NEHU Norms

8.8. Eight Semester Courses

8.8.1. BM-OE-402E: OPEN ELECTIVE COURSES-III

8.8.1.1. (I) BM-OE- 4021 RESEARCH METHODOLOGY

2-1-0 = 3

Subject Code: *BM-OE- 4021*
Subject Name: *Research Methodology and Technical Writing*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Works = 30, End Semester Examination =45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course objectives

1. Gain a comprehensive understanding of the fundamental concepts, principles, and components of research methodology.
2. Explore the various approaches to research, including quantitative, qualitative, and mixed methods, and understand their respective strengths, weaknesses, and applications.
3. Learn about the research process from conceptualization to dissemination, including problem identification, literature review, research design, data collection, analysis, and reporting.

Course outcomes

1. Upon completion of the course, students will demonstrate mastery of various research methodologies, including quantitative, qualitative, and mixed methods approaches.
2. They will understand the principles, concepts, and procedures involved in each research methodology and be able to select and apply appropriate methods based on research questions, objectives, and contexts.
3. Through theoretical learning, practical exercises, and case studies, students will develop a deep understanding of research methodologies, enabling them to design and conduct research studies effectively.

UNIT I

Introduction: Introduction to Research Methodology, he Research Process: Formulating Research Questions & Designing a Research Study Selecting a Research Topic & Developing a Clear Research Question.

UNIT II

Research Design & Data Collection Methods: Exploring Quantitative, Qualitative, & Mixed Methods Approaches; Selecting Appropriate Data Collection Methods (Surveys, Interviews, Observations).

UNIT III

Literature Review & Data Analysis: Conducting a Focused Literature Review; Strategies for Data Analysis (Quantitative & Qualitative Techniques). Patent, Ethics and publications: Patent rights and IPR, Ethics in performing research, Research Paper Planning methods, and Report writing.

Text Books

1. C R Kothari, Research Methodology: methods and techniques, New Age International Publication Ltd 2004
2. J W Creswell, Research Design, Sage South Asia Edition, 4th edition 2019.

Reference Books

1. Edward A. Bender, An Introduction to Mathematical Modeling. Year
2. A. C. Fowler, Mathematical Models in Applied Sciences, Cambridge University Press. Year
3. J. N. Kapoor, Mathematical Modeling, Wiley eastern Limited. Year
4. P. Narayanan (Eastern Law House), Intellectual Property Law. Year

8.8.1.2. (II) BM- OE- 4022 DATA ANALYTICS IN HEALTHCARE 2-1-0=3

Subject Code: *BM-OE-4022*
Subject Name: *Data Analytics in Healthcare*
No. of Hours Per Week: *Lectures-2, Tutorial-1.*
Marks Distribution: *Sessional Works = 30, End Semester Examination =45.*
Questions to be set: *(At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 9 marks).*
Questions to be answered: *Any five*
Duration of End Semester Examination: *Two and Half Hours*

Course Objectives

This course is designed for imparting knowledge of biostatistics and machine learning in healthcare.

Course Outcomes

After the completion of the course students will be able to analyze and apply

1. Appropriate statistical tests for a given set of data.
2. Understand the basics of data analytics and its applications in various fields.
3. Learn techniques for data collection, cleaning, and pre-processing in healthcare domain.
4. Implementation of Machine learning techniques in disease diagnosis.

UNIT I

Sources and presentation data: types of data qualitative and quantitative data and collection methods, organisation of statistical data, investigation and planning, editing, analysis. Data Processing and Presentation: Classification and tabulation, methods of classification and frequency, diagram significance and utility of diagrams limitations of a diagram, Rules of drawing a diagram, kinds of diagram, sampling.

UNIT II

Graphic Presentation of Data: technique of constructing graph, graphs of time series, frequency distribution. Histogram/ bar graph, frequency polygon, graphic location, mode, median. Measurement of central tendency: mean mode and median, measurement of deviation, probability, chi-square test, ANOVA.

UNIT III:

Machine Learning Technique: Fundamentals in Machine Learning, Introduction to predictive modelling techniques: classification, regression, and clustering, Machine learning algorithms for healthcare analytics: decision trees, random forests, support vector machines, etc, Evaluation metrics for predictive models.

Text Books

1. W. W. Daniel and C. L. Cross, “Biostatistics Basic Concepts and Methodology for the Health Sciences”, *Wiley*, 2014.
2. B. Banerjee, “Methods in biostatistics for medical students & research workers”, *Jaypee Brothers Medical Publishers*, 2018.

Reference Books:

1. P. Ramakrishnan, “Biostatistics”, *Saras Publication*, 2019.
2. S. Das, “Data Science for Healthcare: Methodologies and Applications”, 2019.
3. J. VanderPlas, “Python Data Science Handbook”, *O’Reilly*, 2016.

8.8.1.3. (III) BM-OE-4023 MOOCS as per NEHU Norms

8.8.2. BM- P3-404 MAJOR PROJECT

0-0-28=14

Major projects: Students can carry out their major projects in the department under the supervision of at least one teacher. They can also opt to carry out their projects outside NEHU with the collaboration of other National Institutes/ National laboratories/ Industries/ Hospitals within India or abroad, in that case student needs to take a co-supervisor from the department and also needs to take permission from the department supervisor as well as from the Head of the Department. In exceptional cases or based on requirements of host organization the permission may be granted from the Head of the Institution.

The evaluation of the Major project would be done as per RC 20.

8.8.3. BM- P3-406 GRAND VIVA

0-0-6=3

Overall course proficiency will be evaluated as per the RC 20.