RCOEM

Shri Ramdeobaba College of
Engineering and Management, Nagpur

SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR–440013

An Autonomous College affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur, Maharashtra (INDIA)

PROGRAMME SCHEME & SYLLABUS

2023-2024

B.Tech. (BIOMEDICAL ENGINEERING)

About the Department

Biomedical Engineering is the blend of engineering principles and medical procedures in order to create solutions for the healthcare. The aim of Biomedical Engineering programme is to provide educate students so as to bridge engineering with life sciences and represent the biomedical profession with distinction tools that helps the doctors in diagnosis and treatment of different medical conditions. Being a transdisciplinary field, it is behind some of the most important medical breakthroughs today, and has significantly contributed to improvement in quality of life.

The nature of the programme goes beyond the subject barriers and instils the faculty to train the students from both Engineering as well as Science aspects application to Biomedical Engineering. Students will be given an opportunity to explore different dimensions of learning in the field of Biomedical engineering through the blended and experiential learning mode and elevate their education as part of our engineering Honors / Minor Programme with additional certification.

Program Educational Objectives

1. To inculcate the knowledge and skills in designing, manufacturing, testing and instrumentation in the field Biomedical Engineering.

2. Exercise the acquired knowledge to provide economically feasible and socially acceptable solutions for healthcare problems

Program Outcomes

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

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

9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

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

11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

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

Program Specific Outcomes

PSO1: To apply concepts of Biomedical Engineering and Computing Technology to analyze Biomedical systems and signals.

PSO2: To design and develop indigenous medical solutions for healthcare and life sciences

Teaching Scheme for B. Tech. Biomedical Engineering

		Semester I										
Sr. No.	Course Type	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration(Hrs)
				L	T	P		Conti-nuous Evaluation	End Sem Exam	Total	
1	BSC	PHT1002	Physics of Materials	2	1	0	3	50	50	100	3Hrs
2	BSC	PHP1002	Physics of Materials Lab	0	0	2	1	50	-	50	
3	BSC	MAT1001	Applied Mathematics-I	2	1	0	3	50	50	100	3Hrs
4	ESC	BMT1001	Fundamentals of Electrical & Electronics Engineering	3	0	0	3	50	50	100	3Hrs
5	ESC	BMP1001	Fundamentals of Electrical & Electronics Engineering Lab	0	0	2	1	50	-	50	-
6	ESC	BMT1002	Programming for problem solving	3	0	0	3	50	50	100	3Hrs
7	ESC	BMP1002	Programming for problem solving Lab	0	0	2	1	50	-	50	-
8	VSEC	BMP1003	Instrumentation- Maintenance and Repair Lab	0	0	2	1	50	-	50	-
9	AEC	HUT1002	English for Professional Communication	2	0	0	2	50	50	100	2Hrs
10	AEC	HUP1002	English for Professional Communication Lab	0	0	2	1	50	-	50	
11	CCA	HUP0001-1 to HUP0001-10	Liberal/Performing Art	0	0	2	1	50	-	50	-
12	VEC	HUT1004	Foundational Course in Universal Human Value	1	0	0	1	50	-	50	-
			TOTAL	13	2	12	21				

		SEMESTER II									
Sr. No.	Course Type	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	T	P		Conti-nuous Evaluation	End Sem Exam	Total	
1	BSC	CHT2005	Biochemistry	2	0	0	2	50	50	100	2 Hrs
2	BSC	CHP2005	Biochemistry Lab	0	0	2	1	50	-	50	
3	BSC	MAT2001	Applied Mathematics-II	2	1	0	3	50	50	100	3Hrs
4	BSC	MAP2002	Computational Mathematics Lab	0	0	2	1	50	-	50	
5	ESC	BMT2001	Digital Circuit Design	3	0	0	3	50	50	100	3Hrs
6	ESC	BMP2001	Digital Circuit Design Lab	0	0	2	1	50	-	50	
7	BSC	CHP2007	Bioinformatics Lab	0	0	2	1	50	-	50	
8	ESC	BMT2002	Introduction to Digital Fabrication & 3D Printing	2	0	0	2	50	50	100	2 Hrs
9	ESC	BMP2002	Introduction to Digital Fabrication & 3D Printing Lab	0	0	2	1	50	-	50	.
10	VSEC	BMT2003	Computer Workshop	1	0	0	1	50	-	50	
11	VSEC	BMP 2003	Computer Workshop Lab	0	0	2	1	50	-	50	
12	IKS	HUT2001	Foundational Literature of Indian Civilization	2	0	0	2	50	50	100	2 Hrs
13	CCA	PET2001	Sports- Yoga-Recreation	1	0	0	1	50		50	
14	CCA	PEP2001	Sports- Yoga-Recreation	0	0	2	1				
			TOTAL	**13**	**1**	**14**	**21**				

Exit Course Option for I year UG Certificate in Engineering/Tech.		
1	Medical Instruments- With Project	**8**
	OR	
2	Minimum two online course of 4 credits each	**8**

	SEMESTER III										
Sr. No.	Course Type	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	T	P		Conti-nuous Evaluation	EndSem Exam	Total	
1	PCC	BMT3001	Human Anatomy and Physiology for Engineers-I	3	0	0	3	50	50	100	3Hrs
2	MDM	BMT3002	Legal and Ethical Practices of Biomedical Engineering	2	0	0	2	50	-	50	
3	PCC	BMT3003	Analog Devices and Circuits	3	0	0	3	50	50	100	3Hrs
4	PCC	BMP3003	Analog Devices and Circuits Lab	0	0	2	1	50	-	50	
5	PCC	BMT3004	Biomedical Sensors & Measurement Devices	3	0	0	3	50	50	100	3Hrs
6	PCC	BMP3004	Biomedical Sensors & Measurement Devices Lab	0	0	2	1	50	-	50	
7	VSEC	BMT3005	Data Structures and Algorithms	1	0	0	1	50	-	50	
8	VSEC	BMP3005	Data Structures and Algorithms Lab	0	0	2	1	50	-	50	
9	OE	BMT2980	OE-I/MOOC Courses	2	0	0	2	50	50	100	2Hrs
10	AEC	HUT3001	Business Communication	2	0	0	2	50	50	100	2Hrs
11	VEC	HUT3004	Understanding Harmony and Ethical Human Conduct	1	0	0	1	50	-	50	
12	CEP	BMP3006	Field Project-I	0	0	4	2	50	-	50	
			TOTAL	**17**	**0**	**10**	**22**				

Exit Course Option for II year UG Diploma in Engineering/Tech.		
1	Design and Manufacturing of PCB- With Project	**8**
	OR	
2	Radiology Equipment (In Collaboration with Hospitals)/Online Courses	**8**

		SEMESTER IV									
Sr. No.	Course Type	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration(Hrs)
				L	T	P		Conti-nuous Evaluation	EndSem Exam	Total	
1	PCC	BMT4001	Human Anatomy Physiology for Engineers-II	2	0	0	2	50	50	100	2Hrs
2	PCC	BMT4002	Microcontrollers and its application in Healthcare	2	0	0	2	50	50	100	2Hrs
3	PCC	BMP4002	Microcontrollers and its application in Healthcare Lab	0	0	2	1	50	-	50	-
4	PCC	BMT4003	Signals and Systems	3	1	0	4	50	50	100	3Hrs
5	VSEC	BMT4004	Medical Imaging	2	0	0	2	50	50	100	2Hrs
6	OE	BMT2990	OE-II/MOOC Courses	3	0	0	3	50	50	100	3Hrs
7	MDM	BMT4005	Biomedical Project Management	2	0	0	2	50	-	50	-
8	HSSM	MBT4006	Business Management & Entrepreneurship	2	0	0	2	50	50	100	2Hrs.
9	VEC	CHT4001	Environmental Science	2	0	0	2	50	-	50	-
10	CEP	BMP4007	Field Project-II	0	0	4	2	50	-	50	-
			TOTAL	**18**	**1**	**6**	**22**				

		SEMESTER V									
Sr. No.	Course Type	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	T	P		Conti-nuousEvaluation	End Sem Exam	Total	
1	PCC	BMT5001	Biomechanics	3	0	0	3	50	50	100	3 Hrs
2	PCC	BMT5002	Biomaterials	3	0	0	3	50	50	100	3 Hrs
3	MDM	BMT5003	Healthcare application design using FPGA	3	0	0	3	50	50	100	3 Hrs
4	MDM	BMP5003	Healthcare application design using FPGA lab	0	0	2	1	50	-	50	
5	PCC	BMT5004	Analytical & Diagnostic Equipments	3	0	0	3	50	50	100	3 Hrs
6	PCC	BMP5004	Analytical & Diagnostic Equipments Lab	0	0	2	1	50	-	50	
7	PEC	BMT5005	Program Elective-I	3	0	0	3	50	50	100	3 Hrs
8	PEC	BMP5005	Program Elective-I Lab	0	0	2	1	50	-	50	
9	OE	BMT3980	OE-3/MOOC Course	3	0	0	3	50	50	100	3 Hrs
10	CEP	BMP5006	Project-I	0	0	2	1	50		50	
			TOTAL	**17**	**0**	**8**	**22**				

Program Elective - I with Lab			
Course Code	**Course Name**	**Course Code**	**Course Name**
BMT5005-1	Biostatistics	BMP5005-1	Biostatistics Lab
BMT5005-2	Fundamentals of Bio-Sensors	BMP5005-2	Fundamentals of Bio-Sensors Lab
BMT5005-3	Control Systems	BMP5005-3	Control Systems Lab
BMT5005-4	Embedded Systems & IoT	BMP5005-4	Embedded System & IoT Lab

SEMESTER VI											
Sr. No.	Course Type	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration (Hrs)
				L	T	P		Conti- nuous Evaluation	End Sem Exam	Total	
1	PCC	BMT6001	Biomedical Microsystems	3	0	0	3	50	50	100	3Hrs
2	MDM	BMT6002	Biomedical Product and Prototype Design	2	0	0	2	50		50	
3	PCC	BMT6003	Machine Learning for Healthcare	3	0	0	3	50	50	100	3Hrs
4	PCC	BMP6003	Machine Learning for Healthcare Lab	0	0	2	1	50		50	
5	PCC	BMT6004	Biomedical Image Processing	3	0	0	3	50	50	100	3Hrs
6	PCC	BMP6004	Biomedical Image Processing Lab	0	0	2	1	50		50	
7	PEC	BMT6005	Program Elective-II	3	0	0	3	50	50	100	3Hrs
8	PEC	BMT6006	Program Elective-III	3	0	0	3	50	50	100	3Hrs
9	VSEC	BMT6007	Soft skill Development	1	0	0	1	50		50	
10	CEP	BMP6008	Project -II	0	0	4	2	50	50	100	
			TOTAL	**18**	**0**	**8**	**22**				

Exit Course Option for III year Bachelor Degree in B.Sc. (Eng./Tech)		
1	Internship in Centre for Microsystems	8
	OR	
2	Internship at Biomedical Dept. of Hospitals	8

Program Elective – II			
Course Code	**Course Name**	**Course Code**	**Course Name**
BMT6005-1	Molecular Biology	BMT6005-3	Fundamentals of Robotics
BMT6005-2	Bionanotechnology	BMT6005-4	Object Oriented Programming

Program Elective - III			
Course Code	**Course Name**	**Course Code**	**Course Name**
BMT6006-1	Advanced Bioinformatics	BMT6006-3	Embedded System and RTOS
BMT6006-2	Reliability of Medical Equipments	BMT6006-4	Telemedicine

		SEMESTER VII									
Sr. No.	Course Type	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration(Hrs)
				L	T	P		Conti-nuous Evaluation	End Sem Exm	Total	
1	PCC	BMT7001	Implants and Prostheses Design	3	0	0	3	50	50	100	3Hrs
2	PCC	BMP7001	Implants and Prostheses Design Lab	0	0	2	1	50		50	
3	PEC	BMT7002	Program Elective-IV	3	1	0	4	50	50	100	3Hrs
4	PEC	BMT7003	Program Elective-V	3	1	0	4	50	50	100	3Hrs
5	CEP	BMT7004	Research Methodology	3	1	0	4	50	50	100	3Hrs
6	MDM	BMT7005	Hospital Engineering and Management	2	0	0	2	50	-	50	
7	CEP	BMP7006	Project-III	0	0	4	2	50	50	100	
TOTAL				14	3	6	20				

Program Specific Elective – IV		Program Specific Elective – V	
Course Code	**Course Name**	**Course Code**	**Course Name**
BMT7002-1	Programming in Bioinformatics	BMT7003-1	Tissue Engineering
BMT7002-2	Lab on chip Technologies	BMT7003-2	Biomedical Hazards and safety
BMT7002-3	Medical Robotics and Automation	BMT7003-3	Wearable Systems and Mobile Healthcare

Sr. No.	Course Type	Course code	Course Name	Hours/week			Credits	Maximum marks			ESE Duration(Hrs)
				L	T	P		Conti-nuous Evaluation	End Sem Exam	Total	
1	PEC	BMT8001	Program Elective-VI	3	0	0	3	50	50	100	3 Hrs
2	PEC	BMT8002	Program Elective-VII	3	0	0	3	50	50	100	3 Hrs
3	MDM	BMT8003	Data Visualization in Healthcare	2	0	0	2	50	50	100	2 Hrs
4	CEP	BMP8004	Major Project	0	0	8	4	50	50	100	
			OR								
5	CEP	BMP8005	Internship/On-job Training/Research Internship	0	0	0	12	100		100	3Hrs
				8	**0**	**8**	**12**				

Program Elective - VI		Program Elective - VII	
Course Code	**Course Name**	**Course Code**	**Course Name**
BMT8001-1	Healthcare Data Analytics	BMT8002-1	AI for Healthcare
BMT8001-2	Rehabilitation Engineering	BMT8002-2	Computer Analysis of Biomedical Images
BMT8001-3	Bioinspired Robotics	BMT8002-3	Reliability of Medical Equipments

Proposed Scheme for award of Honors specialization
Scheme of Teaching & Examination of Honors specialization in Biomedical Engineering

with Honors in Bioinformatics

Sr. No.	Semester	Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1	III	BMTH3100	Biological Data and Databases	3	0	0	3	50	50	100	3Hrs
2	IV	BMTH4100	Computational Biology and Bioinformatics	3	0	0	3	50	50	100	3Hrs
3	V	BMTH5100	Programming in Bioinformatics	3	0	0	3	50	50	100	3Hrs
4	VI	BMTH6100	Computer Aided Drug design and Chemoinformatics	3	0	0	3	50	50	100	3Hrs
5	VII	BMPH7100	Minor Project (Honors and Multidisciplinary Minor)	6	0	0	6	50		50	
			TOTAL	**18**			**18**				
6.	VIII	BMPH 8100	Major Research Project for Honor with Research and Multidisciplinary Minor	12	0	0	12	100		100	
			TOTAL	**12**			**12**				

Proposed Scheme for award of Minors specialization

Scheme of Teaching & Examination of Honors specialization in Biomedical Engineering With computational Biology

Sr. No.	Semester	Course Code	Course Title	Hours per week			Credits	Maximum Marks			ESE Duration (Hrs)
				L	T	P		Continuous Evaluation	End Sem Exam	Total	
1	III	BMTM3100	Cell Biology	3	0	0	3	50	50	100	3Hrs
2	IV	BMTM4100	Structural Biology	3	0	0	3	50	50	100	3Hrs
3	V	BMTM5100	Bioinformatics	3	0	0	3	50	50	100	3Hrs
4	VI	BMTM6100	Computational Biology	3	0	0	3	50	50	100	3Hrs
5	VII	BMPM7100	Minor Project	6	0	0	6	50		50	
			TOTAL	**18**			**18**				

Open Electives for Other Department Students

OE-I-BMT2980	OE-II BMT2990	OE-III BMT3980
Biomedical Systems (4 credit)	Bioinformatics (2 credit)	Computational Biology (2credit)

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	PHT1002				
Course Title	Physics of Materials				
Scheme & Credits	L	T	P	Credits	Semester
	2	1	0	3	I

Course Outcomes:
After successful completion of the course, the students will be able to:

1. Describe the electrical, thermal and optical properties of materials.
2. Apply Quantum mechanical descriptions for biomedical engineering.
3. Analyze the importance of materials properties for a wide variety of applications.
4. Get theoretical aspects of Semiconducting and dielectric materials for medical applications.
5. Summarizing the properties of superconducting and magnetic materials used in engineering and technology

Syllabus:

Module 1: Electrical and thermal conduction in Solids Classical Theory of electrical conduction in Metals, Resistivity of Materials, Thermal conduction, Electrical conductivity in non-metals

Module 2: Quantum Physics
Electron in Quantum Mechanics, Wave-particle duality, wave packets, Heisenberg uncertainty relations;
Wave function, probability, phenomenon of tunnelling, application to tunnel diode.

Module 3: Laser and Optical Fibre
Interaction of matter and radiation, LASER, spontaneous and stimulated emission, population inversion; Common types of lasers and their applications; Optical fibre, structure, types, propagation in a fibre, modes of propagation, signal attenuation, signal distortion Applications of lasers and fibre in biomedical instrumentation.

Module 4: Semiconductors

Intrinsic and Extrinsic Semiconductors, Carrier concentrations, Drift and diffusion current density, mobility, Junction physics, Semiconductor diode, Zener diode, LED and bipolar junction transistor, Applications of these devices in bioelectric sensors

Module 5: Dielectric Materials and Insulation
Polarization and relative permittivity, Type of polarization, Dielectric loss, Dielectric strength and Insulation breakdown, Capacitor dielectric materials, Piezo-ferro and Pyroelectricity, Applications in Transducers.

Module 6: Magnetic Materials and Superconductivity
Magnetization vector, Permeability and Susceptibility, Magnetic materials, Ferromagnetism, Soft and hard magnetic materials, Ferro fluids for drug delivery, Superconductivity, Phenomenological theory of superconductivity, Superconducting magnets in Biomedical imaging.

Text Book

1. Principles of Electronic Materials and Devices, S. O. Kasap,3rd Edition McGraw Hill.

Reference Books

1. Electrical Engineering Materials, A. J. Dekker, Prentice Hall
2. Introduction to Solid State Physics, Charles Kittle, John Wiley & Sons,Inc.
3. Semiconductor Nanocrystals and Metal Nanocrystals, Physical Properties and DeviceApplications, Eds. Tupei Chen, Yang Liu, CRC Press2017
4. Clinical Applications of Magnetic Nanoparticles, Eds. Nguyên T. K. Thanh, CRC Press 2018
5. How Does MRI work, Eds. D. Weishaupt, V. D. Kochli, B. Marincek, 2nd Edition, Springer2006

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	PHT1002				
Course Title	Physics of Materials				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Outcomes

At the end of the Course the students will learn to:

1. Develop skills required for experimentation and verification of physics laws.
2. Analyze the results obtained through proper graph plotting and Error analysis.
3. Conduct experiments to validate physical behavior of materials/components.
4. Analyze the behavior and characteristics of a basic PN Junction, Zener Diode and other optoelectronic devices.
5. Prepare laboratory reports on interpretation of experimental results

List of Experiments:

1. Basic Measurements
2. Parameter extraction from V-I characteristics of a diode
3. Resistivity measurement of semiconductor by Four Probe method
4. Performance and analysis of Hall Effect in semiconductor to determine the Hall coefficient and carrier concentration of the majority carriers in the given specimen
5. Estimation of energy gap in semiconductor
6. Characteristics and analysis of solar cells
7. Verification of Ohm's law and error analysis of the data using Linear Least Square Fit (LLSF) method
8. Analysis of energy values and wave function using Mathematica software
9. Verification of Planck's constant.
10. Determination of wavelength of LASER light by diffraction grating
11. To find acceleration due to gravity by Simple Pendulum.

Reference:

1. Laboratory manual of the Physics Department
2. Principles and Practices by S. O. Kasap, Prentice Hall2001

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	MAT1001				
Course Title	Applied Mathematics-I				
Scheme& Credits	L	T	P	Credits	Semester
	3	0	0	3	I

Course Objective:

The objective of this course is to familiarize the prospective engineers with techniques in Ordinary differential equation, statistics, probability and differential calculus.
It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

Course Outcomes

On successful completion of the course, the students will able to:

1. Recognize first order ordinary differential equations that can be solved by each of the four methods – Linear DE, exact DE, reducible to linear DE and reducible to exact differential equations and use the appropriate method to solve them.
2. Solve higher order ordinary differential equations with constant and variable coefficients.
3. Find best fit curve by method of least square method and calculate correlation, regressions.
4. Recognize and understand discrete, continuous probability distributions and apply Binomial distribution, Poisson distribution and Normal distribution to appropriate problems.
5. Internalize multivariable calculus and apply it find Jacobians, maxima and minima of function.
6. Solve numerical integrations by Newton coat formulas and Gauss-Legendre Quadrature.

Syllabus

Module 1: First order ordinary differential equations (7 hours)
Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut'stype, Applications of First order Differential Equations.

Module 2: Ordinary differential equations of higher orders (8 hours)
Second order linear differential equations with constant and variable coefficients, method of variation of parameters, Cauchy-Euler equation. Applications of Higher order Differential Equations.

Module 3: Statistics: (7 hours)
Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, correlation and regression – Rank correlation, Multiple regression and correlation and its application in Engineering.

Module 4: Differential Calculus (10 hours)
Taylor's and Maclaurin's series expansions, radius of curvature (Cartesian form), evolutes and involutes, Limit

and continuity of functions of several variables and their partial derivatives, Eulers Theorem, chain rule, total derivative, Jacobians, Maxima, minima and saddle points; Method of Lagrange multipliers.

Module 5: Probability: (8 hours)
Probability spaces, conditional probability, independence, Bay's Theorem, Discrete random variables, Binomial distribution, Poisson distribution, Normal distribution. Relation between binomial, Poisson and Normal distributions.

Textbooks/References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India, 2009.
3. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
4. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
5. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. Theory and Problems of probability and statistics : 2nd ed :J. R. Spiegal ,Schaum series
8. A text book of Applied Mathematics Volume I & II, by P. N. Wartikar and J. N. Wartikar, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).
9. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	BMT1001				
Course Title	Fundamentals of Electrical and Electronics Engineering				
Scheme& Credits	L	T	P	Credits	Semester
	3	0	0	3	I

Course Outcomes

Upon the completion of this course, students will demonstrate the ability to:

1. Understand DC and AC operations.
2. Design different Electric and Magnetic circuits.
3. Develop applications employing appropriate electrical machines.
4. Apply knowledge of two terminal semiconductor devices like diodes to develop applications.

Syllabus

Unit –I: Introduction to DC and AC circuits, Active and passive two terminal elements, Ohms law, Voltage-Current relations for resistor, inductor, capacitor, Kirchhoff's laws, Mesh analysis, Nodal analysis, Voltage and current sources, equivalent resistor, current division, voltage division, Superposition theorem, Thevenin's and Norton's theorems, Star- delta and Delta- star conversions, Maximum Power Transfer Theorem.

Unit –II : Sinusoids, Generation of AC, Average and RMS values, Form and peak factors, concept of phasor representation, J operator, Analysis of R-L, R-C, R-L-C circuits, Introduction to three phase systems - types of connections, relationship between line and phase values.

Unit –III : Single Phase Transformer: Analogy Between electrical and magnetic circuits, solutions of magnetic circuits, Constructional details and Principle of transformer, EMF equation, Phasor diagram on no load and full load, Equivalent circuits, Open circuit and short circuit tests, regulation and efficiency, Hysteresis and eddycurrent losses.

Unit –IV : DC and AC Rotating Machines: Types, Construction, Principle, EMF and torque equation, Application Speed Control, Basics of Stepper Motor, Brushless DC motors, Servo Motors, Solenoid pump.

UNIT - V : PN diode operation- forward bias and reverse bias , Volt-Ampere characteristics of p-n diode, Temperature dependence of VI characteristics, Current components in p-n diode, Diode equation, Transition and Diffusion capacitances,
Breakdown Mechanisms in Semiconductor diodes, Rectifiers: half wave and full wave, Wave shaping circuits

UNIT - VI: Zener diode characteristics and application, Tunnel Diode, LED, LDR, Varactor, Photo diode, PIN diode, Schottky diode, LASER, Applications.

Text books

1. Basic Electrical and Electronics Engineering by S.K.Bhattacharya, Pearson Publications
2. Basic Electrical and Electronics Engineering by D.P. Kothari and I J Nagrath, TMH.

Reference Books

1. Basic Electrical Engineering by Fitzerald and Higginbotham, TMH.
2. Basic Electrical Engineering by I.J Nagrath, TMH.
3. Millman's Integrated Electronics: Jacob Millman, Christos Halkias, Chetan Parikh, McGraw Hill

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	BMP1001				
Course Title	Fundamentals of Electrical and Electronics Engineering Lab				
Scheme& Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Outcomes

Upon the completion of this course, students will demonstrate the ability to:

1. Understand DC and AC operations.
2. Design different Electric and Magnetic circuits.
3. Develop applications employing appropriate electrical machines.
4. Apply knowledge of two terminal semiconductor devices like diodes to develop applications.

List of Experiments

Practical are based on BMT1001 Syllabus

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	BMT1002				
Course Title	Programming for Problem Solving				
Scheme& Credits	L	T	P	Credits	Semester
	3	0	0	3	I

Course Outcomes

On successful completion of course student will learn:

1. Formulate simple algorithms for arithmetic and logical problems, translate the algorithms to programs, test and execute the programs and correct syntax and logical errors.
2. Develop the fundamentals of C programming and choose the decision making and loops statements to solve and execute the given problem.
3. Implement different Operations on arrays also design functions to solve the given problem using C programming.
4. Use of pointers, structures and I/O operations for the formulation of algorithms and programs.

UNIT-I: Introduction to Programming

Introduction to components of a computer system. Idea of algorithm: Steps to solve logical and numerical problems. Representation of algorithm: Flowchart / Pseudocode with examples. Arithmetic expressions and precedence

UNIT-II: C Programming Language

Introduction to C language: Keywords, Constant, Variable, Data types, Operators, Types of Statements: Decision Control Statement-if, if-else, Nested if-else statement, Switch case, Loops statements, etc. Preprocessor Directives.

UNIT-III: Arrays and Functions

Arrays: 1-D, 2-D, Character arrays and Strings. Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection).

User defined and Library Functions, Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference. Recursion.

UNIT-IV: Pointers, Structures and File handling

Structures, Defining structures, Array of Structures, Introduction to pointers, Defining pointers, Pointer arithmetic, pointer operators, Use of Pointers.

Streams in C, Types of Files, File Input/ Output Operations: Modes of file opening, Reading and writing the file, closing the files.

Text Books

1. Programming in ANSI C: E. Balguruswami McGraw Hill
2. Mastering C: K. R. Venugopal and S. R. Prasad, Tata McGraw Hill

Reference Books

1. Programming with C: Byron Gottfried, Schaums Outline Series.
2. Let Us C: Yashwant Kanetkar, BPB Publication

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	BMP1002				
Course Title	Programming for Problem Solving Lab				
Scheme& Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Sr.No.	**Name of the experiment**
1a.	Write a program to print “Hello World”
1b.	Write a program to perform arithmetic operations on two numbers.
2a.	Write a program to find aggregate and percentage of marks.
2b.	Write a program to interchange the contents of two variables.
3a.	Write a program to check whether a number is positive, negative or zero using if statement.
3b.	Write a program to check whether a number is even or odd using if-else statement.
3c.	Write a program to relate two integers using nested if-else statement
4a.	Write a program to check whether a number is prime or not using while loop
4b.	Write a program to display Fibonacci series using for loop
4c.	Write a program to perform a specific operation on operands using switch statement.
5a.	Write a program to display half pyramid of *
5b.	Write a program to display half pyramid of numbers.
5c.	Write a program to display half pyramid of alphabets.
5d.	Write a program to display full pyramid of *
5e.	Write a program to display inverse full pyramid of *
6a.	Write a program to search an element in an array and also count the number of times it came in an array
6b.	Write a program to find largest element in a 3*3 matrix.
6c.	Write a program to concatenate two strings.
7a.	Write a program to find GCD using Recursion.
7b.	Write a program to convert binary number to decimal using user defined function.
8a.	Write a structure to store the data of 10 books.
8b.	Write a program to read first line from file.

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	BMP 1003				
Course Title	Instrumentation- Maintenance and Repair Lab.				
Scheme& Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course outcomes:
Upon the completion of this course, students will demonstrate the ability to:

1. Identify and test different electronic components and Integrated Circuits.
2. read and interpret the data sheets
3. implement a circuit and its debugging
4. create an application-based circuit

Practicals based on:

1. Passive Components and their Testing
2. Testing of Semiconductor Devices
3. Introduction to electronic test and measurement equipment's (Multimeters, CRO, DSO, Function generator, power supply, etc.)
4. Understanding the data sheets of various components and Integrated circuits like 741, 555,74XX
5. Circuit implementation and testing on breadboard
6. Component mounting and soldering on PCB
7. Circuit design and debugging on bread board
8. Circuit simulation tools like multisim etc.
9. Case study on LED strips, Drivers, Chargers, fan regulators, power supplies, and interfacing with controller etc.
10. Mini project

Text **Book:**

1. Troubleshooting Electronic Equipment: Includes Repair and Maintenance, Second Edition, Dr R.S. Khandpur

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	HUT1002				
Course Title	English for Professional Communication				
Scheme& Credits	L	T	P	Credits	Semester
	2	0	0	2	I

Course outcomes:
On successful completion of the course the students will be able to achieve the following:

1. Demonstrate effective use of word power in written as well as oral communication.
2. Understand the techniques of listening and apply the techniques of reading comprehension used in professional communication.
3. Apply the principles of functional grammar in everyday as well as professional communication.
4. Effectively implement the comprehensive principles of written communication by applying various writing styles.
5. Create precise and accurate written communication products.

Syllabus

Module-1: Vocabulary Building
1.1 Importance of using appropriate vocabulary
1.2 Techniques of vocabulary development
1.3 Commonly used power verbs, power adjectives and power adverbs.
1.4 Synonyms, antonyms, phrases & idioms, one-word substitutions and standard abbreviations

Module -2: Listening and Reading Comprehension
2.1 Listening Comprehension: active listening, reasons for poor listening, traits of a good listener, and barriers to effective listening
2.2 Reading Comprehension: types and strategies.

Module -3: Functional Grammar and Usage
3.1 Identifying Common Errors in use of: articles, prepositions, modifiers, modal auxiliaries, redundancies, and clichés
3.2 Tenses
3.3 Subject-verb agreement, noun-pronoun agreement
3.4 Voice

Module-4: Writing Skills
4.1 Sentence Structures
4.2 Sentence Types
4.3 Paragraph Writing: Principles, Techniques, and Styles

Module 5: Writing Practices
5.1 Art of Condensation: Précis, Summary, and Note Making

5.2 Correspondence writing techniques and etiquettes – academic writing
5.3 Essay Writing

Reference Books:

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan.2007
4. On Writing Well. William Zinsser. Harper Resource Book. 2001
5. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	HUP1002				
Course Title	English for Professional Communication Lab				
Scheme& Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Outcomes

On completion of English Lab course, students will be able to achieve the following:
1: Apply effective listening and speaking skills in professional and everyday conversations. 2: Demonstrate the techniques of effective Presentation Skills
3: Evaluate and apply the effective strategies for Group Discussions
4: Analyse and apply the effective strategies for Personal Interviews
5: Implement essential language skills- listening, speaking, reading, and writing

Syllabus:

List of practical
Computer Assisted + Activity Based Language Learning
Practical 1: Everyday Situations: Conversations and Dialogues – Speaking Skills
Practical 2: Pronunciation, Intonation, Stress, and Rhythm
Practical 3: Everyday Situations: Conversations and Dialogues – Listening Skills Activity Based Language Learning
Practical 4: Presentation Skills: Orientation & Mock Session
Practical 5: Presentation Skills: Practice
Practical 6: Group Discussions: Orientation & Mock Session
Practical 7: Group Discussions: Practice
Practical 8: Personal Interviews: Orientation & Mock Session
Practical 9: Personal Interviews: Practice

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001 to 10				
Course Title	Liberal / Performing Arts				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Code	Course Name	Se m.	Hours/wee k	Credits	Maximum marks
					Continuous Evaluation
CCA-02- HUP0001-1	Fundamentals of Indian Classical Dance: Bharatnatayam	I/II	2	1	50
CCA-02-HUP0001-2	Fundamentals of Indian Classical Dance: Kathak	I/II	2	1	50
CCA-02-HUP0001-3	Introduction to Digital Photography	I/II	2	1	50
CCA-02- HUP0001-4	Introduction to Japanese Language and Culture	I/II	2	1	50
CCA-02-HUP0001-5	Art of Theatre	I/II	2	1	50
CCA-02-HUP0001-6	Introduction to French Language	I/II	2	1	50
CCA-02-HUP0001-7	Introduction to Spanish Language	I/II	2	1	50
CCA-02-HUP0001-8	Art of Painting	I/II	2	1	50
CCA-02-HUP0001-9	Art of Drawing	I/II	2	1	50
CCA-02-HUP0001-10	Nature Camp	I/II	2	1	50

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02- HUP0001-1				
Course Title	Fundamentals of Indian Classical Dance: Bharatnatayam				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Outcomes

On completion of English Lab course, students will be able to achieve the following:

1. Understand the importance of dance and Bharatnataym as an Indian dance form.
2. Develop skills to perform the dance form at its basic level.
3. Evaluate their strengths and interest to take bridge course to give Pratham (1^{st} level formal exam of Bharatnatayam)

Syllabus:

Practical -1: Orientation in Bharatnatayam
Practical-2: Tattu Adavu till 8, NaattaAdavu 4 Steps, PakkaAdavu 1 step, Metta Adavu 1 Step, Kuditta Metta Adavu 4 Steps, Practical -3: Practice sessions
Practical-4:Tatta Kuditta Adavu (Metta), TattaKudittaAdavu (Metta) 2 Steps, TirmanamAdavu 3 Steps, KattuAdav - 3 Steps, Kattu Adav - 3 Steps
Practical-5: Practice sessions
Practical-6: Tiramanam (front) 3 Steps, Repeat of Tiramanam
(Overhead) 3 Steps, Practical-7: practice sessions
Practical – 8: final practice sessions and performances.

Recommended reading

1. Introduction to Bharata's Natyasastra, Adya Rangacharya, 2011
2. The Natyasastra and the Body in Performance: Essays on the Ancient Text, edited by Sreenath Nair, 2015
3. Bharatanatyam How to ... : A Step-by-step Approach to Learn the Classical Form, Eshwar Jayalakshmi, 2011

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-2				
Course Title	Fundamentals of Indian Classical Dance: Kathak				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Outcomes
On completion of the course, students will be able to achieve the following:
1: Understand the importance of dance and Kathak as an Indian dance form
2: Develop skills to perform the dance form at its basic level.
3: Evaluate their strengths and interest to take bridge course to give Prarambhik (1^{st} level formal exam of Kathak).

Syllabus
Practical -1: Orientation in Kathak. Correct posture of kathak, Basic Movements and exercise Stepping, Chakkar of 5 count (Bhramari),
Practical -2: practice sessions of practical 1
Practical -3:Hastaks, Hastaks and Steppings, Reciting asamyukta Mudra shloka, Hastak and steppings
Practical -4: practice sessions of practical 3
Practical -5: Todas and Asamyukta hasta mudra shlok, Vandana of Shlok, 2 Todas and Vandana, Ghante Ki Tihai,
Practical -6: practice sessions of practical 5
Practical -7: 2 1 Chakkardar Toda and Ginnti Ki Tihai, 2 Todas and 1 Chakkardar Toda, practice sessions
Practical -8: Final performances.

Recommended reading
1.Kathak Volume1 A "Theoretical & Practical Guide" (Kathak Dance Book), Marami Medhi & Debasish Talukdar, 2022, Anshika Publication (13 September 2022)

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-3				
Course Title	Introduction to Digital Photography				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course outcome:
At the end of the course the students will be able to achieve the following:
1: Develop an understanding of the technical aspects and aesthetics of Photography.
2: Apply the rules of digital photography for creating photographs.
3: Develop skills to enhance photographs through post processing.
4: Create a portfolio of their photographs in selected genre.

Syllabus
Practical 1: Orientation in digital photography: Genres, camera handling and settings
Practical 2: Rules of Composition
Practical 3: Rules of Composition: practice sessions
Practical 4: Understanding Exposure and Art of Pre-Visualization
Practical 5: Rules of Composition andArt of Pre-Visualization: practice sessions
Practical 6:Post Processing Photographs and Portfolio creation
Practical 7: Post Processing Photographs: practice sessions
Practical 8:Portfolio finalization and presentation in selected genre.

Reference material

1. Scott Kelby (2020) The Digital Photography Book: The Step-by-Step Secrets for how to Make Your Photos Look Like the Pros, Rocky Nook, USA
2. Larry Hall (2014) Digital Photography Guide: From Beginner to Intermediate: A Compilation of Important Information in Digital Photography, Speedy Publishing LLC, Newark
3. J Miotke(2010) BetterPhoto Basics: The Absolute Beginner's Guide to Taking Photos Like a Pro, AMPHOTO Books, Crown Publishing Group, USA

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-4				
Course Title	Introduction to Japanese Language and culture				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course outcome

1: Gain a brief understanding about Japan as a country and Japanese culture.
2: Develop ability to use vocabulary required for basic level communication in Japanese language. 3: Able to write and read the first script in Japanese language.
4: Able to frame simple sentences in Japanese in order to handle everyday conversations 5: Able to write in basic Japanese about the topics closely related to the learner.

Syllabus

Practical-1: Orientation about Japan, its language, and its culture
Practical-2: Communication Skills 1: Vocabulary for basic Japanese language
Practical -3: Practice sessions
Practical-4: Writing Skills 1: Reading and writing first script in Japanese
Practical-5: Practice sessions
Practical- 6: Communication Skills 2: framing sentences
Practical- 7: Practice sessions
Practical- 8: Writing Skills 2: Write basic Japanese and practice

Recommended reading

1. Marugoto Starter (A1) Rikai - Course Book for Communicative Language Competences, by The Japan Foundation, Goyal Publishers & Distributors Pvt. Ltd (ISBN: 9788183078047)
2. Japanese Kana Script Practice Book – Vol. 1 Hiragana, by AmeyaPatki, Daiichi Japanese Language Solutions (ISBN: 9788194562900)

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-5				
Course Title	Art of Theatre				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Outcome:
On completion of the course, students will be able to achieve the following:
1: Understand and synthesize the working of the prominent genres of theatre across the world.
2: Apply the skill of voice and speech in theatre and public speaking
3: Apply the art of acting and also develop generic skills such as confidence, communication skills, self-responsibility, motivation, commitment, interpersonal skills, problem solving, and self-discipline.
4: Apply skills acquired related to technical/production aspects of theatre and also develop problem solving and interpersonal skills.

Syllabus
Practical 1: Orientation in theatre
Practical 2: Voice and Speech training
Practical 3: Voice and Speech training: practice sessions
Practical 4: Art of acting
Practical 5: Art of acting: practice sessions
Practical 6: Art of script writing
Practical 7: Art of script writing: practice sessions
Practical 8: Final performances

References:

1. Boleslavsky, R. (2022). Acting: The First Six Lessons (1st ed., pp. 1-92). Delhi Open Books.
2. Shakthi, C. (2017). No Drama Just Theatre (1st ed., pp. 1-171). Partridge.
3. Bruder, M., Cohn, L. M., Olnek, M., Pollack, N., Previto, R., &Zigler, S. (1986). A Practical Handbook for the Actor (1st ed.). Vinatge Books New York.

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-6				
Course Title	Introduction to French Language				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course outcomes:

On successful completion of the course the students will be able to achieve the following:

1. Demonstrate basic knowledge about France, the culture and similarities/differences between India and France
2. Learn to use simple language structures in everyday communication.
3. Develop ability to write in basic French about themselves and others.
4. Develop ability to understand beginner level texts in French

Syllabus

List of Practicals

Practical-1: Orientation about France, the language, and culture
Practical-2: Communication Skills 1: Vocabulary building for everyday conversations
Practical -3: Practice sessions
Practical-4: Reading and writing Skills : Reading and writing simple text in French
Practical-5: Practice sessions
Practical-6: Communication Skills 2: listening comprehension
Practical-7: Practice sessions
Practical-8: Writing Skills: Write basic French and practice

Recommended reading

1. 15-minute French by Caroline Lemoine
2. Cours de Langue et de Civilisation Françaises by G. Mauger Vol. 1.1
3. Cosmopolite I by Natalie Hirschsprung, Tony Tricot

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-7				
Course Title	Introduction to Spanish Language				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course outcomes:

On successful completion of the course the students will be able to achieve the following:

1. Demonstrate basic knowledge about Spain, the culture and similarities/differences between India and France
2. Learn to use simple language structures in everyday communication.
3. Develop ability to write in basic Spanish about themselves and others.
4. Develop ability to read and understand beginner level texts in Spanish

Syllabus

List of Practicals

Practical-1: Orientation about Spain, the language, and culture
Practical-2: Communication Skills 1: Vocabulary building for everyday conversations Practical -3: Practice sessions
Practical-4: Reading and writing Skills : Reading and writing simple text in Spanish
Practical-5: Practice sessions
Practical-6: Communication Skills 2: listening comprehension
Practical-7: Practice sessions
Practical-8: Writing Skills: Write basic Spanish and practice

Recommended reading

1. 15-Minute Spanish by Ana Bremon
2. Aula Internacional 1 by Jaime Corpas ,Eva Garcia, Agustin Garmendia.
   Chicos Chicas Libro del Alumno by María Ángeles Palomino

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-8				
Course Title	Art of Painting				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course outcome:
At the end of the course the students will be able to achieve the following:
1: Become familiar with the basic methods, techniques & tools of painting.
2: Train the eye and hand to develop sense of balance,
proportion and rhythm. 3: Develop the ability to observe
and render simple natural forms.
4: Enjoy the challenging and nuanced process of painting.

Syllabus
Practical 1: Orientation in Painting tools & basics of lines, shapes, light, shadows and textures
Practical 2:The art of observation how to see shapes in drawing
Practical 3: Introduction Water colorhow to handle water paints
Practical 4:Introduction to acrylic colorshow to handle acrylic paints
Practical 5: Explore layering paint and capturing the quality of light with paint.
Practical 6: Create landscape painting
Practical 7: Create Abstract painting
Practical 8: Paint on Canvas (try to recreate any famous painting)

Reference material

1. Drawing made easy by Navneet Gala; 2015th edition
2. Alla Prima II Everything I Know about Painting--And More by Richard Schmid with Katie Swatland
3. Daily Painting: Paint Small and Often To Become a More Creative, Productive, and Successful Artist by Carol Marine

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-9				
Course Title	Art of Drawing				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course outcome:
At the end of the course the students will be able to achieve the following:
1: Become familiar with the basic methods, techniques & tools of drawing.
2: Train the eye and hand to develop sense of balance, proportion and rhythm.
3: Develop the ability to observe and render simple natural forms.
4: Enjoy the challenging and nuanced process of drawing.

Syllabus
Practical 1: Orientation in Drawing tools & basics of lines, shapes, light, shadows and textures
Practical 2: The art of observation how to see shapes in drawing
Practical 3: One/two-point basic linear perspective
Practical 4: Nature drawing and landscapes
Practical 5: Gestalt principles of visual composition
Practical 6: Figure drawing: structure and proportions of human body
Practical 7: Gesture drawing: expression and compositions of human figures
Practical 8: Memory drawing: an exercise to combine the techniques learnt

Reference material

1. Drawing made easy by Navneet Gala; 2015th edition
2. Perspective Made Easy (Dover Art Instruction) by Ernest R. Norling

Syllabus for B. Tech. I Semester
Department of Biomedical Engineering

Course Code	CCA-02-HUP0001-10				
Course Title	Nature Camp				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Objective: To create an opportunity for the students to develop affinity with nature and thus subsequently impact their ability to contribute towards sustainability of nature.
Course outcome:
After the completion of the course the students will be able to do the following:
CO1: Develop an affinity with nature by observing and understanding it marvels with guidance from experts
CO2: Develop an understanding of the challenges and solutions associated with nature and its conservation.

Course content
In collaboration with the Forest Department and/or a local NGO working in the field of environment conservation, this course would be conducted in 24 hours. Students will be taken to a tiger reserve in Central Indian region or Forest fringe villages or work with an NGO from Central Indian region working on natural resource management. The camps (for 2 days) will cover any one of the following topics as decided by the course coordinator:

1. Awareness about each element of biodiversity (camps on moths, butterflies, birds, other wildlife etc)
2. Environment management (water, forest, wildlife) – practices of Forest Department in managing a tiger reserve, and other aspects of water and forest conservation.
3. Sustainable natural resource management - initiatives by rural communities and local NGOs
4. Man-animal conflict and solutions (socio-economic and technical) – role of local communities and Forest Department
5. Traditional practices in environment conservation – role of local communities and local NGOs

Course Code	HUT1004/ HUT2004				
Course Title	Foundation course in Universal Human Values				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	I

Course Objectives:

• To help the student see the need for developing a holistic perspective of life
• To sensitize the student about the scope of life – individual, family (inter-personal relationship), society and nature/existence
• To strengthen self-reflection
• To develop more confidence and commitment to understand, learn and act accordingly

Course outcome:

On completion of course, students will be able to achieve the following:

CO1: Develop a holistic perspective of life
CO2: Better understanding of inter-personal relationships and relationship with society and nature.
CO3: An ability to strengthen self-reflection

Syllabus

Unit 1:- Aspirations and concerns

Need for Value Education: Guidelines and content of value education.
Exploring our aspirations and concerns: Knowing yourself, Basic human aspirations Need for a holistic perspective, Role of UHV; Self-Management: harmony in human being

Unit 2:- Health

Harmony of the Self and Body, Mental and physical health; Health for family, friends and society.

Unit 3:- Relationships and Society

Harmony in relationships, Foundational values: Trust, Respect, Reverence for excellence, Gratitude and love; harmony in society; harmony with nature.

Reference Material

The primary resource material for teaching this course consists of

1**. Text book:**

R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

2. **Reference books**:

a) B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow.
Reprinted 2008.
b) PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers.
c) Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
d) Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
e) Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, Universe Books.

f) Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
g) A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
h) E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
i) A.N. Tripathy, 2003, Human Values, New Age International Publishers.

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	CHT2005				
Course Title	Biochemistry				
Scheme & Credits	L	T	P	Credits	Semester
	2	0	0	2	II

Course Outcomes:
After the successful completion of the course, students will be able;
1. To comprehend the basic concepts of the quantitative analysis.
2. To apply the knowledge to understand the structure and function of biological molecules
3. Demonstrate and comprehend the principles of a wide range of biophysical and biochemical techniques.
4. To understand spectroscopic methods used for qualitative and quantitative analyses.

Syllabus
Module 1: Introduction to Biochemistry [8 Hours]
Introduction to Biochemistry, weak acid and bases, pH, buffers, physiological buffers in living systems, Hydrogen Bonding, Hydrophilic and Hydrophobic Interactions, van der Waals Interactions, Impurities in natural water, hardness and alkalinity,

Module 2: Introduction to Biomolecules [7 Hours]
Carbohydrates: Chemistry of few carbohydrates , Glycolysis and glycogenolysis, glycogensis,
Amino Acid: Chemistry properties and metabolism.
Proteins: primary, Secondary, tertiary and quaternary structure, Isoenzymes.
Lipids: Chemistry, Metabolism of fatty acids, Phospholipids, Cholesterol regulation of metabolism.
Nucleic Acid: Chemistry of DNA and RNA,
Enzymes: Classification and role in biological system, Michaelis- Menten equation.
Vitamins: Structure and functions of some vitamins

Module 3: Fundamental Biochemical Concepts [7 Hours]
Basic concept in Techniques – Different methods of concentration calculations,
Purification techniques: Centrifugation, Filtration, Adsorption, Absorption, Sedimentation, Paper chromatography

Module 4: Material Characterization using different Spectroscopic Techniques [8 Hours]
Fundamentals of spectroscopy, concept of photochemical reaction, absorption, Beers Lamberts law, Infrared Spectroscopy, Electronic Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, MRI.
Fundamentals of X-Ray Diffractions (XRD), X-Ray Fluorescence (XRF) spectroscopy.

Suggested Books:

1. J. Michael Hollas, Modern Spectroscopy, Fourth Edition, John Wiley and Sons, 2004.

2. William Kemp, Organic Spectroscopy, Third Edition, Palgrave Publication, 1991.
3. S. S. Dara, A Textbook of Engineering Chemistry, S. Chand Publications.
4. P. C. Jain and Monica Jain, Engineering Chemistry, Dhanpat Rai Publication.
5. Y. Keith Wilson and J. Walkar, Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition, Cambrige University Press, 2007.
6. Satyajit D. Sarker and Lutfun Nahar, Chemistry for Pharmacy Students General, Organic and Natural Product Chemistry, Wiley-Interscience and Sons Limited, 2007.
7. Thomas M. Devlin, Textbook of Biochemistry with Clinical Correlations, Fourth Edition, Wiley- LISS, 1977.
8. A. Upadhayay, K. Upadhayay, N. Nath, Biophysical Chemistry (Principles and Techniques), Himalaya Publishing House, 2009.
9. David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman and Company, New York, 2008.
10. Elsa Lundanes, Léon Reubsaet and Tyge Greibrokk, Chromatography Basic Principles, Sample Preparations and Related Methods, Wiley-VCH.
11. 11. Natural Products -O.P. Agrawal Volume -1 & 2
12. Engineering Chemistry – B. K. Sharma

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	CHP2005				
Course Title	Biochemistry Lab				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	II

Course Outcomes:
The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.
The students will learn to:

1. Estimate the amount of different impurities in water/waste water/food samples.
2. Measure molecular/system properties such as surface tension, viscosity of aqueous or other industrially important liquids/mixtures etc.
3. Synthesize a polymer or drug molecule or nano-material.
4. Use principle of spectroscopic and chromatographic techniques.

List of Experiments: [Any Eight from the List]

1. Preparation of different Solutions: Molar solution, Normal solution and percent solution and Determination of concentration.
2. To find out types of alkalinity and estimation of their extent in the water sample.
3. Estimation of hardness present in the water sample by complexometric titration method using EDTA.
4. Determination of COD in waste water sample.
5. Determination of BOD/ dissolved oxygen in waste water sample.
6. To study effect of bondings of water molecules with electrolyte (NaCl/KCl) and non-electrolyte solute (Soap) in the solution through Surface Tension Determination.
7. Synthesis of Drug/Polymer and its study.
8. Separation of different organic compounds by paper chromatography.
9. Determination of Fe content in food sample.
10. Demonstrations of laminar flow equipment
11. Spectroscopic/Colorimetric determine of wavelength of maximum absorption of chemical/biological compound in solution and determination of concentration using Lambert-Beer's Law.
12. Demonstration of chromatographic techniques: Gas chromatography, HPLC
13. Demonstrations of organic spectral techniques: IR, NMR.

Suggested Books/Reference Books:

1. S. S. Dara, A Textbook on Experiments and Calculations in Engineering Chemistry, S. Chand Publications.
2. J. B. Yadav, Advanced Practical Physical Chemistry, Krishna's Prakashan Media (P) Limited.
3. A. J. Elias, Collection of Interesting General Chemistry Experiments, Universities Press Publications.
4. V. K. Ahluwalia, S. Dhingra and A. Gulati, College Practical Chemistry, Universities Press Publications.

5. Ashutosh Kar, Advanced Practical Medicinal Chemistry, New Age International Publisher.

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	MAT2001				
Course Title	Applied Mathematics-II				
Scheme & Credits	L	T	P	Credits	Semester
	2	1	0	3	II

Course Objective:
The objective of this course is to familiarize the prospective engineers with techniques in Calculus and multivariate analysis. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Course Outcomes
On successful completion of the course, the students will able to:

1. Interpret the solutions of system of linear equations and use the concepts of Eigen values, Eigen vectors to find diagonalization of matrices, reduction of quadratic form to canonical form.
2. Evaluate definite and improper integrals using Beta, Gamma functions. Also trace cartesian curves.
3. Solve multiple integration by change of order, change of variable methods and apply it to find area, volume, mass and center of gravity.
4. Understand geometric meaning of gradient, curl, divergence
5. Perform line, surface and volume integrals of vector-valued functions.
6. Analyze and compare different sets of data and classify the data by means of diagrams and graph.

Syllabus
Module 1: Matrices: (8 hours)
Algebra of matrices, Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Eigen values and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, Orthogonal transformation and quadratic to canonical forms, Introduction to n-dimensional space.

Module 2: Integral Calculus: (8hours)
Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Tracing of curves(Cartesian form)

Module 3: Multiple Integrals (10 hours)
Multiple Integration: Double and triple integrals (Cartesian and polar), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: area, mass and volume by double integration, Center of mass and Gravity (basic concepts).

Module 4 : Vector Calculus (Differentiation)(7hours)
Scalar point function, Vector point function, vector differentiation, gradient, divergence and curl, directional derivatives with their physical interpretations, solenoidal and irrotational motions, Scalar

potential function.

Module 5 : : Descriptive Statistics (7- Lectures)(Only for Bio-Medical Engineering)
Types of statistical data: categorical, ranked, discrete, and continuous. Distinction between univariate, bi-variate, and multivariate statistics, Visualization techniques such as joint contingency tables, scatter plots, 2D histograms and line graphs, Measures of central tendency and Dispersion.

Topics for self learning

Rolle's theorem, Mean value theorems, Indeterminate forms, Applications of definite integrals to evaluate perimeter, area, surface areas and volumes of revolutions.

Textbooks/References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics Volume I & II, Pune VidhyarthiGrihaPrakashan, Pune-411030 (India).
6. Biomedical Statistics -Shantikumar Yadav , Sompal Singh, Ruchika Gupta
7. Theory and Problems of Probability and Statistics - M.R. Spiegal (Mc Graw Hill) Schaum Series

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	BMT2001				
Course Title	Digital Circuit Design				
Scheme& Credits	L	T	P	Credits	Semester
	3	0	0	3	II

Course Outcomes

1. Understand fundamental of minimization and implementation of digital logic circuits using logic gates.
2. Design and analysis of combinational digital circuit.
3. Design and analysis of sequential digital circuit.
4. Understand fundamental of logic families, memory elements & programmable logic devices (FPGA) and implementation with programmable logic devices.
5. Model, Verify and Implement digital circuits with the aid of HDL & EDA tools.

Syllabus

Module – 1 Logic Simplification

Binary Arithmetic, Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Logic Gates, combinational Logic Optimization Techniques.

Module – 2 Combinational logic Design

Comparators, Multiplexers, Demultiplexer, Encoder, Decoder, Arithmetic Circuit Design, Barrel Shifter, ALU.

Module – 3 Sequential Logic Design

Latches, Flip flop – S-R, JK, D, T and Master-Slave JK FF, counters, Shift registers, Finite state machines & their implementation with respect to biomedical application.

Module – 4 Logic Families and Programmable Devices

Introduction to logic families, comparison and interfacing, Concept of PLDs like ROM, PAL, PLA, CPLDs, FPGA etc. Logic implementation using Programmable devices, Memories & their architecture.

Module – 5 Overview of Digital Design with HDL

Different methodologies and its implementation process. Introduction to Verilog HDL for Digital Circuit implementation, language constructs

Module – 6 Modeling Styles.

Structural, sequential, behavioural constructs, test bench, synthesis of HDL.

Text Book

1. Fundamentals of Digital Logic with Verilog: Stephen Brown and Zvonko Vranesic, Mc Graw Hill,2nd Edition.

Reference Books

1. Fundamentals of digital circuits: A. Anand Kumar, Prentice-Hall of India, 4th Edition.
2. Modern digital Electronics: R.P. Jain, Tata McGraw Hill, 4 th Edition
3. Digital Electronic Principles: Malvino, PHI, 3rd Edition.
4. Verilog HDL: A Guide to Digital Design and Synthesis: Samir Palnitkar, Prentice Hall PTR, 2ndEdition.

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	CHP2007				
Course Title	Bioinformatics Lab				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	II

Course Outcomes:
After the successful completion of the course, students shall be able

1. To understand the basics of chemical structure representation and molecular descriptors.
2. To familiarize students with chemical databases and their applications in bioinformatics.
3. To introduce computational methods used in bioinformatics, including molecular docking and/or QSAR (Quantitative Structure-Activity Relationship) analysis.
4. To provide hands-on experience with software tools commonly used in bioinformatics.
5. To develop skills in data analysis and interpretation for chemical data.

Module 1: Protein sequence analysis
Introduction of various bio-important structures, scope and applications of Computational biology, Molecular modeling.
Hands on Tutorials for the uses of soft-wares/programming for DNA and Protein sequence Analysis, Molecular modelling, etc.

Module 2: Molecular Docking

Future of computational modelling and prediction systems in molecular docking. Brief introduction about interactions of drugs with binding sites in human body cell.
Hand On Tutorials for the uses of software /programming for bio-informatics databases search, predictions of affinity, modelling, BLAST programs etc.

Text Books

1. Xinkun Wang, "Next-Generation Sequencing Data Analysis", CRC Press, 2016, ISBN 9781482217896
2. Tamar Schlick, "Molecular Modelling and Simulation: An interdisciplinary discipline", Springer, 2nd edition, 2010, ISBN 9781441963505
3. Darren Flower, Jon Timmis, "In Silico Immunology", Springer Link, 2007, ISBN: 978-0- 387-39238-

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	BMT2002				
Course Title	Introduction to Digital Fabrication & 3D Printing				
Scheme & Credits	L	T	P	Credits	Semester
	2	0	0	2	II

Course Objectives

The students will develop their skills in CAD Modelling, Exporting CAD Data to prototyping, Meshing and Postprocessing of RP Models

Course Outcomes

On successful completion of the course, the students will be able to:

1. Understand the significance of CAD CAM technologies in a reducing time to market for any product
2. Analyse and select different prototyping methods used for conversion of CAD data to physical model
3. Analyse and select the different materials and process for digital fabrication in various real-life application
4. Analyse and apply the technique of CAD and Reverse Engineering for Geometry Transformation in Additive Manufacturing

Syllabus

Module 1: Introduction to CAD and Concept Design

: Introduction to Views, Concept of Projections, Design Process, Typical Design Cycle, Role of CAD and Modified Design Cycle, Introduction to CAD, Boundary Representation of Objects, CAD Geometry Representations, Geometric Transformations, 3D Modelling Software pre-requisites, working architecture.

Module 2: 3D printing Fundamentals

Need for time compression in product development, Need for Digital Fabrication Technologies. Historical Development of Prototyping methodologies, Advantages and Limitations, Classifications of Terminologies related to Digital Fabrication, Advantages and Limitations, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

Module 3: Introduction to Solid, Liquid and Powder Based Process

Classification of different Prototyping based methods, Mechanisms, working, advantages, Limitations, Case Studies of Different Prototyping Process, Customized Implants and Prosthesis using Digital Fabrication- Introduction and Case Studies

Module 4: Reverse Engineering and Digital Fabrication

Reverse Engineering Philosophy, Point Cloud Extraction, File Formats like STL, IGES etc, Reengineering for Digital Representation, STL Format, STL File Problems,Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

Text books

1. Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles and Applications -, World Scientific publications, Third Edition, 2010.
2. CAD-CAM CAE Theory and Practice- Ibrahim Zaid

Reference Books

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006
3. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials,
4. Engineering Materials and Processes, Springer International Publishing AG 2018
5. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	BMP2002				
Course Title	Introduction to Digital Fabrication & 3D Printing Lab				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	II

Course Objectives

The students will develop their hands-on skills in 3D modelling, Point Cloud Exporting to CAD, STL File Generation, Pre and Post Processing of STL Files

Course Outcomes

1. On successful completion of the course, the students will be able to
2. Demonstrate Proficiency in reading of drawings and interpreting the data from the drawing
3. Demonstrate proficiency in 3D modelling using any CAD software
4. Demonstrate ability to scan any physical 3D object and export the point cloud in CAD
5. Demonstrate ability to convert the 3D model into STL file and carry out pre-processing and post processing of STL file using any CAD software

Experiments on following topics

1. Create orthographic representation and isometric representation of 3D objects and read and interpret data from them
2. Working on CAD software to draw primary shapes and create 3D drawings using different commands
3. Assembling Creative Designs in CAD Software
4. Simulation Processing the CAD data (Selection of Orientation, supports generation, Slicing, Tool path generation)
5. Working on reverse engineering machine, for point scanning and point plotting from physical product to CAD environment
6. Understand the conversion of point cloud from physical product to CAD for any given product
7. Convert the complete CAD model into STL file format with pre and post processing.
8. Converting CT/MRI scan data into STL file using 3D Doctor Software (Demo)

Syllabus for II Semester B Tech
Department of Biomedical Engineering

Course Code: BMT 2003			**Course: Computer Workshop**
L: 01 Hrs	T: 00 Hrs	P: 00 Hrs/week	Total Credit: 01

Course Objectives

The students will develop their skills in Data Pre-processing, Visualization and Analysis using Microsoft Excel, and Tableau.

Course Outcomes

On successful completion of the course, the students will:

1. Understand advanced Excel features for data visualization
2. Connect Tableau to multiple data sources, process and transform data to prepare it for reporting and visualization
3. Draw insights from data dashboards and visualizations that allows understanding and help a business make critical decisions

Syllabus

Unit-I: Introduction to data visualization: Different data visualization tools, Microsoft Excel functions, Add Ins. for data tools, Data Analysis Tab in Excel. Pivot Tables, Recording Macros. GUI of Microsoft Excel for better visualizations.

Unit-II: Introduction to Tableau: GUI of Tableau, Features of Tableau, building blocks of Tableau, connecting to data sources, getting data from excel files, using Tableau desktop.

Text books

1. Communicating Data with Tableau by Ben Jones, Copyright © 2014 Ben Jones. All rights reserved. Printed in the United States of America. Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

Syllabus for II Semester B Tech Department of Biomedical Engineering			
Course Code: BMP2003			**Course: Computer Workshop Lab**
L: 00 Hrs	T: 00 Hrs	P: 02 Hrs/week	Total Credit: 01

Course Objectives

The students will develop their hands-on skills in Data Pre-processing, Visualization and Analysis using Microsoft Excel and Tableau.

Course Outcomes

On successful completion of the course, the students will:

1. Execute advanced Excel features for data visualization
2. Make reports for visualization
3. Create data dashboards and visualizations for critical decisions in business.

Experiments on following topics

1. **Microsoft Excel** functions, Add Ins. for data tools,
2. Data Analysis Tab in Excel.
3. Pivot Tables
4. Recording Macros.
5. GUI of Microsoft Excel for better visualizations.
6. **Tableau** Desktop UI & Connecting to Data
7. Making Visualizations,

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	HUT2001				
Course Title	Foundational Literature of Indian Civilization				
Scheme & Credits	L	T	P	Credits	Semester
	2	0	0	2	II

Course outcome:

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

1. Understand the Indian knowledge system and its scientific approach
2. Get introduced to the Vedic corpus and recognize the multi-faceted nature of the knowledge contained in the Vedic corpus
3. Understand the salient features of the philosophical systems of the Vedic and non-Vedic schools
4. Develop a basic understanding of the ancient wisdom recorded in various

   Indian literary work

Syllabus

Module 1: Overview of Indian Knowledge System: Importance of ancient knowledge, defining IKS, IKS classification framework, Historicity of IKS, Some unique aspects of IKS.

Module 2: The Vedic corpus: Introduction of Vedas, four Vedas, divisions of four Vedas, six Vedangas, Distinct features of Vedic life.

Module 3: Indian Philosophical systems: Development and unique features,Vedic schools of philosophy, Samkhya and Yoga School of philosophy, Nayay and Vaisesika school of philosophy, Purva-mimamsa and Vedanta schools of Philosophy, Non-vedic philosophies: Jainism, Buddhism, and other approaches

Module 4: Indian wisdom through ages: Panchtantras, Purans: contents and issues of interests, Itihasa: uniqueness of the two epics (Ramayan and Mahabharata), Key issues and messages from Ramayana, Mahabharata – a source of worldly wisdom; Indian ancient Sanskrit literature: Kalidas, Vishakadutta, Bhavbhuti, Shudraka*

*any one text as decided by the course teacher

Reference material

1. B. Mahadevan, Vinayak Rajat Bhar, Nagendra Pavana R. N., “Introduction to Indian Knowledge System: Concepts and Applications” PHI, 2022
2. S.C. Chatterjee and D.M. Datta, An introduction to Indian Philosophy, University of Calcutta, 1984

Syllabus for B. Tech. II Semester
Department of Biomedical Engineering

Course Code	PET-PEP1001				
Course Title	SPORTS- YOGA-RECREATION				
Scheme & Credits	L	T	P	Credits	Semester
	1	0	2	2	II

Aim of the Course

The course aims at creating awareness about the fundamentals of Physical Education, Sports, Yoga, Recreation and its effectiveness to promote Health and wellness through Healthy Lifestyle.

Objectives of the Course

To impart the students with basic concepts of Sports, Yoga and Recreational activities for health and wellness.
To familiarize the students with health-related Exercise and evaluate their Health-related Fitness.
To make Overall growth & development with team spirit, social values and leadership qualities among students through various sports, games and Yogic activities.
To create Environment for better interaction and recreation among students as neutralizer for stress through various minor and recreational games.

Course Outcomes:

On completion of the course, students will be able to:
Understand fundamental skills, basic principle and practices of sports and Yoga.
Practically learn the principles of implementing general and specific conditioning of physical exercises and yoga.
Develop Health-related fitness and Body-mind co-ordination through various fitness activities, sports, recreational games and yoga.
practice Healthy & active living with reducing Sedentary Life style.

Course Content:

Module 1: - Theory: Introduction
Meaning, Definition and Importance of Health & Wellness Dimensions of Health and Wellness Factors influencing Health and Wellness Physical Fitness, Nutrition, Habits, Age, Gender, Lifestyle, Body Types Health & Wellness through Physical Activities, Sports, Games, Yoga and Recreation activities Causes of Stress & Stress relief through Exercise and Yoga Safety in Sports

Module 2: - Practical- Exercises for Health and Wellness
Warm-Up and Cool Down - General & Specific Exercises, Physical Fitness Activities
Stretching Exercises, General & Specific Exercises for Strength, Speed, Agility, Flexibility, coordinative abilities, Cardiovascular Exercises, Assessment of BMI, Relaxation techniques, Physical Efficiency Tests

Module 3: - Yoga
Shukshma Vyayam, Suryanamaskar, Basic Set of Yogasanas – Sitting, standing, supine and prone position, Basic Set of Pranayama & Meditation

References:

1. Russell, R.P. (1994). Health and Fitness Through Physical Education. USA: Human Kinetics.
2. Uppal, A.K. (1992). Physical Fitness. New Delhi: Friends Publication.
3. AAPHERD "Health related Physical Fitness Test Manual."1980 Published by Association drive Reston Virginia
4. Kumar, Ajith. (1984) Yoga Pravesha. Bengaluru: Rashtrothanna Prakashana.
5. Dr. Devinder K. Kansal, A Textbook of Test Evaluation, Accreditation, Measurements and Standards (TEAMS 'Science)

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMT3001				
Course Title	Human Anatomy and Physiology for Engineers - I				
Scheme and Credits	L	T	P	Credits	Semester
	3	0	0	3	III

Course Outcomes

After completion of the course student will be able to:

1. Understand human physiology at a cellular, tissue, and organ systems level.
2. Recognize the integration and control of the different physiological systems and their roles in maintaining homeostasis.
3. Identify the structural and functional aspects of Human Anatomy
4. Classify the process of development and aging of organ systems

Syllabus

Module – 1 Fundamentals of Anatomy, Cells and Tissues

Introduction to Human Body; Cell Level Organization; Types of cell and their function; Tissue Level Organization; Types of Tissue and there function

Module – 2 Integumentary System and Special senses

Structure and Function of Skin; Accessory structures of skin; Skin Wound Healing; Development and Aging of Integumentary System; Anatomy and Physiology of Olfaction, Gustation, Vison, Hearing and Equilibrium senses; Aging of senses

Module – 3 Skeletal System

Structure and Function of Bone and the Skeletal System; Bone formation; Fracture and Repair; Types of Bones; Structure and Function of Axial and Appendicular Skeleton; Joint and its classification; Types of Movements at Synovial Joints and Types of Synovial Joints; Aging of Joints

Module – 4 Muscular System

Overview of Muscular Tissue; Skeletal Muscle Tissue; Working of Muscle Fibers; Metabolism; Control of Muscle Tension; Types of Muscle Fiber and Tissue; Regeneration; Development and Aging of Muscle.

Module – 5 Digestive System

Overview of the Digestive System; Layers of the GI Tract; Neural Innervation of the GI Tract; Structure and Function of Organs of Digestive system; Phases of Digestion; Development and Aging

Module – 6 Excretory system

Overview of Renal Physiology; Anatomy and Physiology of the Kidney; Glomerular Filtration; Reabsorption and Secretion; Waste Management of in other body system; Aging of Urinary System

Text Book

1. Principles of Anatomy & Physiology, 13th Edition, Gerard J. Tortora and Bryan Derrickson, John Wiley & Sons, Inc
1. Human Anatomy & Physiology Standalone Book, Marieb, Human Anatomy & Physiology, 11th Edition, Pearson.

Reference Books

1. Atlas of Human Anatomy Professional Edition, 7th Edition, Frank H. Netter
2. Ross & Wilson Anatomy and Physiology in Health and Illness, 13th Edition.
3. Clinical Anatomy: Applied Anatomy for Students and Junior Doctors, 14th Edition.
4. Gray's Anatomy for Students, 4th Edition.

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMT3002				
Course Title	Legal and Ethical Practices of Biomedical Engineering				
Scheme and Credits	L	T	P	Credits	Semester
	2	0	0	2	III

Course Outcomes:

After completion of the course the student will be able to:

1. Understand biomedical engineers' role in device development and the importance of intellectual property rights in biomedical research.
2. Identify and differentiate between various types of intellectual property rights relevant to biomedical engineering.
3. Analyze the legal aspects of medical negligence in India, including criminal, civil, and consumer protection laws.
4. Interpret the key provisions of the Medical Devices Rules, 2017, including licensing authorities' roles and functions of national accreditation bodies.
5. Demonstrate competency in the importation process of medical devices, from license application to compliance and license management procedures.

Syllabus

Unit I (7 Hours): Biomedical Engineers and Intellectual Property

Role of Biomedical Engineers as a device developer; Intellectual Property Rights and their Significance in Biomedical Research; Types of Intellectual Property Rights;

Unit II (6 Hours): Medical Negligence – Laws in India

Criminal negligence; civil negligence; Negligence under consumer protection act

Unit III (6 Hours): The Medical Devices Rules

Short title, Commencement and Application of the rules; Licensing authorities and their power of delegation; National Accreditation bodies and their functions

Unit IV (6 Hours): Import of Medical Devices

Application for grant of import license; Grant of import license; Conditions to be complied with by license holder; Suspension and cancellation of license;

Text Book

1. "Biomedical Engineering and Intellectual Property: The Law of Biomedical Science" by Katarzyna Sikora, Adam T. Sutton, and Stanley N. Lapidus.

Reference Books

1. Law Relating to Intellectual Property Rights by Dr. M. K. Bhandari (Central Law Publications)
2. Intellectual Property For The Medical Professional by Joseph S. Heino, Booklocker.Com Inc
3. Medical Negligence & Legal Remedies by Anoop K Kaushal, Universal Law Publishing an imprint of LexisNexis
4. Y.V. Rao's Law relating to Medical Negligence by Asia Law House.
5. The Medical Devices Rules, 2017.

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	HUT3001				
Course Title	Business Communication				
Scheme & Credits	L	T	P	Credits	Semester
	2	0	0	2	III

Course Objective

The course aims to develop the skills of students to proficiently craft compelling business documents and employ strategic verbal communication techniques. By honing these skills, students will gain the ability to convey ideas persuasively and interact confidently in diverse business contexts.

Course Outcomes

On successful completion of the course the students will be able to achieve the following:

CO1: Understand the fundamentals of business communication.
CO2: Apply tools and techniques to create effective workplace correspondence.
CO3: Analyse and apply visual design principles to create business documents.
CO4: Understand and evaluate information to draft reports.
CO5: Apply and evaluate strategies for effective communication for employment.

Syllabus:

UNIT 1: Fundamentals of Business Communication (6 Hours)
Definition of communication, Emergence of communication as a key concept in the Corporate and Global world, Types- Internet, Blogs, E-mails, social media, Channels- Formal and Informal: Vertical, Horizontal, Diagonal, Grapevine, Persuasive Communication- Negotiation Skills, PAC concept

UNIT 2: Business Correspondence (6 Hours)
Planning, Writing, and Completing Business Messages
Personnel Correspondence: Job Application Letter, Letter of Acceptance of Job Offer, Letter of Resignation, Letter of Appointment, Promotion and Termination, Letter of Recommendation
Trade Correspondence: Inquiry, Order, Credit and Status Enquiry, Complaints, Claims, Adjustments, Consumer Grievance Letters

UNIT 3: Visual and Content Creation (6 Hours)
Visual design principles, Ethics of visual communication, selecting visuals for presenting data, Content Creation: Website, Help file, User Guides, Promotional leaflets and fliers

UNIT 4: Report (4 Hours)
Basic formats and types of reports - Feasibility, Progress, Project, Case Study Evaluation, Agenda, Notices, Minutes of Meeting, Organizational announcements, Statement of Purpose.

UNIT 5: Communication for Employment (4 Hours)
Pre-interview technique- NOISE Analysis, Job Description and Resume, Creating LinkedIn Profile, Effective use of job portals, Business etiquette.

Text Books

1. Sharon Gerson, Steven Gerson, "Technical Communication: Process and Product", 2018, Pearson
2. Courtland L Bovee, John V Thill and Roshan Lal Raina "Business Communication Today", 14th edition Pearson
3. P.D. Chaturvedi and Mukesh Chaturvedi, Fundamentals of Business Communication, Pearson Publications, 2012.

Reference Books

1. Shalini Verma, Business Communication, Vikas Publishing House Pvt. Ltd., 2015.
2. Sanjay Kumar, Pushpa Lata, Communication Skills, 2nd Edition, Oxford Publication, 2018
3. William Strunk Jr. and E.B. White, The Elements of Style, Allyn & Bacon, A Pearson Education Company, 2000

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMT3003				
Course Title	Analog Devices and Circuits				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	III

Course Outcomes

At the end of this course, students will demonstrate the ability to:

1. Understand operation of BJT and BJT as amplifiers
2. Understand operation of MOSFET and MOSFET as amplifiers
3. Analyze circuit of differential, feedback, power amplifier.
4. Understand Fundamental of operational amplifier and its basic circuit.
5. Evaluate the function of linear and nonlinear application of opamp.

Syllabus

Module – 1 Bipolar Junction Transistors (BJT)

Bipolar Junction Transistors Device structure and Physical Operation, Input- Output characteristics in CE configuration, , Load line concept, Biasing techniques, The Ebers-Moll Model and small signal model of BJT. BJT as Amplifier.

Module –2 Metal oxide Field-effect Transistors (MOSFET)

MOSFET – Device structure and Operation, Volt-Ampere Characteristics, DC operating point, biasing the MOSFET; small signal model of the MOSFET ,Applications of MOSFET as Amplifier.

Module - 3 Fundamental of Amplifier

Frequency response of amplifier, Feedback amplifier, Power Amplifiers, Basic differential amplifier and its operation. dc characteristics, operation with common mode and differential mode input voltage, common mode gain, differential mode gain and CMRR

Module – 4 Op-amp fundamentals

Block schematic, Ideal and practical operational amplifier characteristics, open loop Op-amp circuits, concept of virtual ground and negative feedback in Op_amp circuits.

Module – 5 Op_amp basic circuits

Inverting and Non inverting Op-amp circuits with negative feedback, Voltage gain, input resistance, output resistance, Bandwidth of Op_amp with negative feedback, Op-amp parameters: Offset voltage, bias and offset current, CMRR, Slew rate.

Module – 6 Opamp applications

Summing amplifiers, integrators and differentiators, difference amplifiers, instrumentation amplifiers, Op-amp based sinusoidal oscillators, Op-amp based filters ,Clipper, Clamper, Comparators, Schmitt trigger circuits.

Text Book

1. Linear Integrated Circuits: D.Roy Choudhary, Shail Jain, 4thEdition, New Age International
2. Microelectronic Circuits: Theory and Applications : Adel S. Sedra, Kenneth C. Smith, Arun N.Chandorkar, SeventhEdition, Oxford University Press, 2017.

Reference Books

1. Operational Amplifiers: Ramakant Gaikwad, Second edition, Prentice Hall.
2. Design with Operational Amplifiers and Analog Integrated Circuits, 3rd Edition: Sergio Franco, TMH.
3. Operational Amplifiers and Linear Integrated Circuits, 4th Edition: Coughlin Driscoll, PHI
4. Introduction to Operational Amplifier theory and applications: J. V. Wait, L. P. Huelsman and GAKorn, McGrawHill,1992
5. Electronic Circuits: Analysis and design: Donald Neaman, Third Edition, McGraw Hill, 2006.

BMP3003 (Credit 1) Practical will be based on theory syllabus.

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMT3004				
Course Title	Biomedical Sensors and Measurement Devices				
Scheme and Credits	L	T	P	Credits	Semester
	3	0	0	3	III

Course Outcomes:

After completion of the course the student will be able to:

1. Understand basic fundamentals principles involved in transducers and sensors.
2. Demonstrate the working of a given biomedical instrumentation system.
3. Apply the knowledge of various sensors to different medical applications.
4. Compare and discriminate different available sensors and identify the most appropriate for a particular biomedical application
5. Design and develop systems for a given biomedical applications.

Syllabus

Unit I (7 Hours):

Basics of Sensors and Measurement: General Structure of the measurement system, Classification of transducer, Performance characteristics of transducer, Static - dynamic Characteristics, Basic transduction techniques, Bridge based Measurement: DC bridges, AC bridges.

Unit II (7 Hours):
Temperature and Displacement Measurement: Resistance Temperature Detectors, Thermistors, Radiant Temperature Sensors, ICs based Temperature Sensors, Fiber-optic Temperature Sensor, Strain gauges, Load cell, Biomedical Application of Strain gauges, Displacement Sensors, Motion Transducer.

Unit III (7 Hours):

Pressure and Flow Measurement: Types of flows in physiological System, Differential pressure flow transducers, Ultrasound flow transducers, Electromagnetic flow transducers, Pressure Transducer, Physiological Pressure Measurement, Absolute Pressure Sensors for Implantable Devices, Differential Pressure Measurements, Indirect Measurement of Systolic, Diastolic, and Mean Blood Pressure

Unit IV (6 Hours):
Electrochemical Sensors: Electrode Potential and Reference Electrode, Potentiometric Sensors, Amperometric Sensors, Impedimetric Sensors, Electroanalytical methods.

Unit V (7 Hours):

Optical Transducer: Principle of the functioning of pulse oximetry, Transmission configuration of pulse oximetry, IR light sources and detectors, Transmittance and reflectance pulse oximetry, Beer-Lambert law. Capnography: Electromechanics and solid-state transducers, Case study: Advancing Sensors in Biomedical and Biotechnology.

Unit VI (7 Hours):

Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer-Controlled Test Systems, Measurement and display system: Electronic multi-meter, True-RMS meter, Digital storage oscilloscope, Digital meter, Frequency, Time interval and pulse width measurement basics, Portable display units

Text Book

1. Khandpur, R. S, Handbook of Biomedical Instrumentation", 3rdedition, McGraw Hill Education (India) Private Limited, 2017

Reference Books

1. John G Webster, Medical Instrumentation - Application and Design. 4th edition, John Wiley& Sons, NY
2. Tatsuo Togawa, Toshiyo Tamura , Biomedical Transducers & Instruments , P. Ake Oberg. CRC
3. Vera Lucia Da Silveira Nantes Button, Principles of Measurement & Transduction of Biomedical Variables, Elsevier
4. D. Patranabis , Sensors & Transducers , Phi Learning Pvt. Ltd

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMP3004				
Course Title	Biomedical Sensors and Measurement Devices Lab				
Scheme and Credits	L	T	P	Credits	Semester
	0	0	2	1	III

Course Outcomes:

After completion of the course, the student will be able to:

1. Analyze the characteristics and working principles of sensors and transducers, including Linear Variable Differential Transformers (LVDT), photoelectric, photovoltaic, and photoconductive transducers.
2. Apply strain gauge techniques to measure strain in mechanical structures, such as cantilever beams, using half-bridge and full-bridge configurations.
3. Demonstrate the principles of temperature control systems using a Resistance Temperature Detector (RTD) and explore ultrasonic sensors for proximity detection and distance measurement.
4. Perform measurements of physiological parameters, including blood pressure using auscultatory, oscillometric, and piezoelectric methods, and pulse measurement using photoelectric transducers.
5. Design and implement sensor-based projects to integrate theoretical concepts with practical applications in real-world scenarios.

Experiment List

1. Determine the unknown resistance using a Wheatstone bridge.
2. Study the input and output characteristics of a Linear Variable Differential Transformer (LVDT).
3. Determine the strain developed in a cantilever beam using half-bridge and full-bridge strain gauges.
4. Study the principle and working of temperature control using a Resistance Temperature Detector (RTD).
5. Study the use of an ultrasonic sensor as a proximity detector and distance meter.
6. Measurement of blood pressure using auscultatory and Oscillo metric methods.
7. Blood pressure measurement using a piezoelectric transducer.
8. Pulse measurement using a photoelectric transducer.
9. Study of photoelectric, photovoltaic, and photoconductive transducers.
10. Project based on sensors.

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMT3005				
Course Title	Data Structures and Algorithms				
Scheme and Credits	L	T	P	Credits	Semester
	1	0	0	1	IV

Upon the completion of this course, students will be able to:
1. Understand the fundamental knowledge about Python programming language.
2. Apply concept of lists, dictionaries, tuples and sets to write python programming.
3. Develop the python programs for file handling, exception handling and string processing.
4. Apply the concepts of Object-Oriented Programming.
5. Understand and apply the various data structures and algorithms used in programming languages.
6. Create a python program using OpenCV

Syllabus

Module-1 (3Hrs)

Introduction to programming, algorithms and data structures, Introduction to Python variables, operators, control flow statements, loops statements.

Module-2 (4Hrs)

Python strings, lists, tuples, array, dictionary. Python functions: optional arguments, default values, passing functions as arguments, Nested functions, higher order functions on lists: map, list comprehension.

Module-3 (3Hrs)

Exception handling, Basic input/output, Handling files, String processing.

Module-4 (4Hrs)

Introduction to Python object oriented Programming, Abstract data-types, Classes and objects in Python.

Module-5 (3Hrs)

Introduction to Data structures and algorithm: stack, queue, Heaps. Sorting, Hashing & Searching, Linked lists, Trees and tree algorithm, graphs and graph algorithm.

Module-6 (3Hrs)

Introduction to Open CV python, reading, writing and storing images. Various operations on images with Open CV python.

Text Book

1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, “Data Structures and Algorithms in Python”, Wiley, 2013.
2. Kenneth A. Lambert, “Fundamentals of Python:Data Structures” Cengage Learning PTR, 2014.

Reference Books

1. Gowrishankar S, Veena A, “Introduction to Python Programming”, 1st Edition, CRC Press/Taylor & Francis, 2019. ISBN-13: 978-0-8153-9437-2.
2. 2. Benjamin Baka, “Python Data Structures and Algorithms” Published by Packt Publishing Ltd., 2017.
3. Gary Bradski, Adrian Kaehler, “Learning OpenCV Computer Vision with the Open CV Library”, O'Reilly Media, 2008.

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMT3005				
Course Title	Data Structures and Algorithms				
Scheme and Credits	L	T	P	Credits	Semester
	0	0	1	1	III

1. Programs based on control flow statements.
2. Program based on loop control statements.
3. Program based on List.
4. Program based on Dictionary
5. Program based on tuple.
6. Program based on Set.
7. Program based on exception and file handling
8. .Program based on data structure.
9. Program based on OpenCV.

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMT2980				
Course Title	Additive Manufacturing (Open Elective I)				
Scheme and Credits	L	T	P	Credits	Semester
	4	0	0	2	III

Course Outcomes:

On successful completion of the course, the students will be able to:

1. Recall the historical development and key concepts of Additive Manufacturing, alongside identifying commonly used terms in the field.
2. Comprehend the advantages of Additive Manufacturing and summarize the process chain, including 3D modelling and CAD geometry representations.
3. Apply fundamental automated processes and utilize 3D modelling software for Additive Manufacturing, demonstrating practical skills.
4. Analyse various Additive Manufacturing systems and evaluate their suitability for specific applications, fostering critical thinking.
5. Evaluate the effectiveness and potential impact of Additive Manufacturing on industries, demonstrating informed judgment and insight.

Syllabus

Module - 1: Introduction to Additive Manufacturing

History of AM, Principle of AM, Procedure of AM, AM Classification and Feedstock Materials, Commercial Market of AM, Applications of AM.

Module - 2: Additive Manufacturing Process Chain

Fundamental Automated Processes, Process Chain, 3D Modeling, Introduction to CAD, Boundary Representation of Objects, CAD Geometry Representations, Geometric Transformations, 3D Modelling Software pre-requisites, Working architecture.

Module - 3: Liquid/Solid/Powder-Based Additive Manufacturing Systems

3D Systems' Stereolithography Apparatus (SLA), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS) and other fabrication methodologies. Screen-printing, laser writing and other methods, understanding different applications of fast prototyping fabrication methods through case studies.

Module - 4: Additive Manufacturing Data Formats

File Formats like STL, Reengineering for Digital Representation, STL Format, STL File Problems, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, Surgi Guide, 3-matic, Simplant, Mesh Lab. Case studies to understand the applications of 3DP.

Text Books:

1. Chua C. K., Leong K. F. and LIM C. S. Rapid prototyping: Principles and Applications -, World Scientific publications, Third Edition, 2010.
2. CAD-CAM CAE Theory and Practice by Ibrahim Zaid, Third Edition, McGraw Hill Education, 2019.

Reference Books:

1. Liou L. W. and Liou F. W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007
2. Kamrani A. K. and Nasr E. A., "Rapid Prototyping: Theory and practice", Springer, 2006
3. Mahamood R. M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials,
4. Engineering Materials and Processes, Springer International Publishing AG 2018
5. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004
6. Additive Manufacturing Methods: A Brief Overview, Journal of Scientific and Engineering Research, 2018, 5(8):123-131

Syllabus for B.Tech IV Semester
Department of Biomedical Engineering

Course Code	BMT4001				
Course Title	Human Anatomy and Physiology for Engineers-II				
Scheme and Credits	L	T	P	Credits	Semester
	2	0	0	2	IV

Course Outcomes:

After completion of the course student will be able to:

Understand the concepts and knowledge of the cardiovascular, Respiratory, immune, Gastrointestinal

1. Recognize the integration and control of the different physiological systems and their roles in maintaining homeostasis.
2. Classify the process of development and aging of organ systems
3. Communicate information related to these systems through written, verbal, or multimedia formats in order to assess current knowledge, answer investigative questions.

Syllabus

Module-1: Respiratory System

Respiratory system Anatomy; Exchange and Transport of Oxygen and Carbon dioxide; Control of respiration; Development and Aging of Respiration System

Module-2: Cardiovascular System

Blood and its Property and Function; Anatomy of Heart; Cardiac Muscle tissue and conduction system; the cardiac cycle and output; structure and function of blood vessels; Capillary exchange; Hemodynamics; Circulatory route; Aging and development of cardiovascular system

Module-3: Nervous System

Overview of nervous system; Generation and transmission of electrical signals in neurons; Anatomy and Physiology of Spinal Cord; Brain; Somatic and Autonomic nervous systems

Module-4: Fluid, Electrolyte & Acid Base Homeostasis

Fluid compartment and Balance; Electrolyte in Body Fluids; Acid Base balance; Aging.

Module- 5: The Lymphatic and Immune system

Structure and Function of Lymphatic system; Innate and Adaptive Immunity; Ceel and Antibody Mediated Immunity; Self recognition and Self Tolerance; Aging and stress on Immunity

Module 6: Reproductive system

Male and Female Reproductive system; The Female reproduction cycle; Development and Aging of reproductive systems.

Text Book:

1. Principles of Anatomy & Physiology, 13th Edition, Gerard J. Tortora and Bryan Derrickson, John Wiley & Sons, Inc
2. Human Anatomy & Physiology Standalone Book, Marieb, Human Anatomy & Physiology, 11th Edition., Pearson.

Reference Books:

1. Atlas of Human Anatomy Professional Edition, 7th Edition, Frank H. Netter
2. Ross & Wilson Anatomy and Physiology in Health and Illness, 13th Edition.
3. Clinical Anatomy: Applied Anatomy for Students and Junior Doctors, 14th Edition.
4. Gray's Anatomy for Students, 4th Edition.

Syllabus for B.Tech III Semester
Department of Biomedical Engineering

Course Code	BMT4002				
Course Title	Microcontrollers and its application in Healthcare				
Scheme and Credits	L	T	P	Credits	Semester
	2	0	2	3	IV

Course Outcomes

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

1. Understand the architecture and organization of microprocessor & microcontroller.
2. Analyze the interrupts, timing diagram, and memory interface of microprocessors.
3. Write the basic programming of microprocessor & microcontroller.
4. Design the microcontroller based system by interfacing the peripherals
5 Develop microprocessor and microcontroller based systems in biomedical applications

Syllabus

Module I: (5Hrs)

Introduction to RISC and CISC processors architecture, Introduction to Intel's 8085, architecture, pin diagram, bus concepts, addressing modes. Instruction set, simple programs.

Module II: (5Hrs)

Memory interfacing, Timing diagram of 8085, interrupts in 8085, Introduction to X86.

Module III: (4Hrs)

Introduction to Microcontroller architecture and family, The Arduino Development Environment, Creating sketches, including Libraries, using example codes, Arduino Playground, Debugging using the Serial Monitor. Power management in microcontroller: Sleep mode, idle mode, Run Mode.

Module IV: (6Hrs)

Study of Interfacing of LED, SSD, LCD, Switches & Relays, DC motor, Stepper motor, Servo-motors.

Module V: (6Hrs)

Sensors, Digital Versus Analog, Connecting Digital and Analog Sensors, Temperature sensors, Humidity Sensors, Obstacle sensors, Ultrasonic sensor, Real-Time Clock (RTC), Accelerometer and gyro.

Module VI: (4Hrs)

Commutation Protocols used with microcontroller: Parallel communication, Serial communication, Serial Peripheral Interface (SPI), I2C Communication, Introduction to USB. Biomedical instrumentation with microcontrollers. Microcontroller based biomedical applications case study

TEXT BOOKS:

1. Microprocessor: Architecture, Programming & applications with 8085; Ramesh S. Gaonkar; Penram International, 5th Edition.
2. Arduino for Beginners: Essential Skills Every Maker Needs, John Baichtal, Pearson Education, Inc., 1st edition.

REFERENCE BOOKS:

1. Advanced Microprocessors and Peripherals; A. K. Ray & K. M. Bhurchandi; McGraw Hill, 3rd Edition.
2. Arduino Cookbook by Michael Margolis, O'Reilly Media, Inc., 1st edition.
3. Beginning C for Arduino By Jack Purdum (ebook).

BMT4002 (Credit 1) Practical will be based on theory syllabus.

Syllabus for B.Tech IV Semester
Department of Biomedical Engineering

Course Code	BMT4003				
Course Title	Signals and System				
Scheme and Credits	L	T	P	Credits	Semester
	3	1	0	4	IV

Course Outcomes

1. Understand concepts of mathematics used for the analysis of signals and systems in time and frequency domain.
2. Analyze the Continuous Time signals and systems through Laplace Transform and fourier transform
3. Recognize the need for of discretizing a signal and importance of Nyquist Criterion
4. Process the signal in Z domain for various discrete time systems
5. Design Finite Impulse Response (FIR)filters and Infinite Impulse Response (IIR) filters , and evaluate the performance to meet expected system specifications

Syllabus

Module – 1 Introduction to Signals and Systems

Elementary continuous & discrete time signals, introduction to biomedical signals like electroencephalogram (EEG), electrocardiogram (ECG),electro-oculography (EOG), surface electromyogram (EMG), galvanic skin response(GSR), basic operations on signals, classification of signals, introduction to system and system classification.

Module – 2 Continuous and Discrete Signal and Systems

Continuous and Discrete Signal and Systems - Periodic, aperiodic and impulse signals; Sampling theorem; Classical method, convolution integral and their properties, causality, correlation, stability, step response, impulse response of interconnected systems, Periodic, aperiodic and impulse signals, transfer function, the frequency response of first and second-order linear time-invariant systems, convolution, correlation, Fourier transforms

Module – 3 Overview of Laplace Transform

Need of Laplace Transform, Unilateral and bilateral Laplace Transform, properties criterion, concept of Region of Convergence (ROC), inverse of Laplace Transform, the S-plane and BIBO stability criterion and Causality, Transfer function, Solution of differential equations, Analysis of LTI System Using L.T. and Applications, relation between Fourier Transform and Laplace Transform.

Module -4 Discrete Fourier Transform (DFT)

Frequency Domain sampling, DFT and its properties, filtering of long data sequences using overlap- save method and overlap-add method, Radix-2 Fast Fourier Transform (FFT) algorithms.

Module – 5 Z-transform

Z-transform and its properties, analysis of LTI discrete time system using Z transform, Relation between Laplace and Z transform, Inverse Z-transform, Unilateral Z- transform.

Module – 6 Basic of FIR filter and IIR filter

Digital filter concepts, FIR filters Design techniques: Fourier series, Windows (Rectangular, Bartlett, Hanning, Hamming, Blackman, Kaiser) and Optimal frequency sampling, structures for FIR systems. Design of Butterworth and Chebyshev filters, structures for IIR systems.

Text Book

1. Signals and Systems: A.V. Oppenhemn, A.S. Willsky and Hamid Nawab; Pearson publication, 2nd edition 2015.
2. Discrete Time Signal Processing, Alan V. Oppenheim & Ronald W. Schafer, 3 Edition, Pearson.

Reference Books

1. Principles of Linear Systems & Signals: B.P. Lathi, Oxford Press, Second Edition, 2009
2. Signals and Systems; Simon Haykin, Barryvan Veen; John Wiley and Sons, 2nd edition, 2003.
3. Signals and Systems; A. NagoorKani, McGrawHill Education, 2015
4. Digital Signal Processing: A Computer based Approach, Sanjit K. Mitra, 4 Edition Mc-Graw Hill.
5. Digital Signal Processing: Principles, Algorithms & Applications, John G. Proakis & Dimitris G. Manolakis, PHI, 4 Edition
6. Digital Signal Processing, A NagoorKani, 2 Edition Mc-Graw Hill.

Course Code	BMT4004				
Course Title	Medical Imaging				
Scheme and Credits	L	T	P	Credits	Semester
	2	0	0	2	IV

Course Outcomes

On completion of this course, the students will be able to

1. Understand the physics and instrumentation of different imaging modalities.
2. Summarize the advantages and limitations of different imaging modalities in clinical practice.
3. Demonstrate the issues related with the image quality (resolution, noise, contrast etc).
4. Apply concepts, laws, and theories to solve instrumentation related problems.
5. Compare and discriminate different modalities and identify the most effective imaging modality for particular, examination.

Syllabus

Module1 (6 Hrs) X-Rays: Properties, types, generation, medical use, interaction with matter, physical parameters of X-Ray imaging: spatial resolution, contrast, noise, modulation transfer function (MTF) etc.

Module II (6 Hrs) Computed Tomography (CT)/Positron Emission Tomography (PET): CT scan: Image formation, Radon Transform & Fourier Slice Theorem, CT instrumentation, Image reconstruction PET scan: definition, purpose, procedure and results.

Module III (6 Hrs) Magnetic Resonance Imaging (MRI): Basic principle, imaging methods, MRI instrumentation, slice section- plain &contrast studies, image contrast, factors affecting image quality

Module IV (6 Hrs) Ultrasound Imaging: Basic acoustics, ultrasound terminologies, interaction of ultrasound with matter, ultrasound transducers and instrumentation, ultrasound display modes etc

Module V (5 Hrs) Optical Coherence Tomography: Principles, instrumental designs and biomedical applications

Module VI (6 Hrs) Photoacoustic Imaging: Fundamentals, photoacoustic image contrast, penetration depth and spatial resolution, photoacoustic imaging configurations (Photoacoustic Tomography, Photoacoustic Microscopy etc.) photoacoustic sensing techniques (Photoacoustic spectroscopy, Photoacoustic Doppler flowmetry, Photoacoustic thermometry), applications

Text Books:

1. Medical Imaging Technology, Mark A Haidekker, Springer New York
2. Hand book of Biomedical Instrumentation, R. S. Khandpur, McGraw Hill Education (India) Private Limited, New Delhi

Reference Books:

1. Medical Imaging Signals and Systems, Jerry L. Prince, Jonathan M. Links, Pearson Education, Inc., publishing as Prentice Hall, 1 Lake Street, Upper Saddle River, NJ
2. Physical principles of Medical Imaging, Perry Sprawls, Jr. -2nd, Medical Physics Publishing Madison, Wisconsin, Aspen Publishers.

Course Code	BMT4006				
Course Title	Business Management and Entrepreneurship				
Scheme& Credits	L	T	P	Credits	Semester
	2	0	0	2	IV

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understanding of the evolution of management, its history and the development of important concepts.
2. Exposure to the practice of management in contemporary organization
3. Ability to analyze and understand management as well as exploring and developing their own personal philosophy of management.
4. To provide an introduction to entrepreneurship and its development process.
5. To provide understanding about various sources of finances and business expansion.
6. To provide conceptual clarification of networking, e-business and growth strategies.

Syllabus

Module I: (5 Hours)

Introduction to Business Management: Nature – Function – Definition – Importance of Management
Scope of Management Is management a science or art? – Management Functions and skills Development of Management Thought (Contribution of Taylor, Fayol, Hawthorne experiments).

Module II: (5 Hours)

Planning: Concept – Nature – Importance – Types of Planning – Strategic and Operational Plans (Policy, Procedures, Methods, Rules, Budget, Mission, Objectives), Planning Premises.

Module III: (6 Hours)

Organizing: Concept – Principles involved – Types of organization structure - Combining Jobs: Departmentation, Span of Control, Delegation of Authority. Decision Making: Concept – Types - Steps involved– methods of decision making – Committee Decision Making.

Module IV: (7 Hours)

Entrepreneurship – Meaning, Types, Qualities of an Entrepreneur, Classification of Entrepreneurs, Factors influencing Entrepreneurship, Entrepreneurship Development Programmes (EDP), Business Idea: Sources & Evaluation .

Module V: (6 Hours)

Entrepreneurial Finance: Debt, Venture Capital, Buying a Business: challenges, The Search, Process, Scrutiny, Valuation, Negotiation, Franchising, Commercial Banks.

Module VI: (6 Hours)

Entrepreneurship E-Business, Networking: Starting & Managing a Network, Infrastructure, Best Practices, Growth Strategies: Stages of Growth, Global Expansion, Relocation, Financing Growth, Business Cases

Text Books

1. Principles and Practice of Management: L M Prasad, Sultan Chand & Sons educational.
2. Entrepreneurship: Rajeev Roy, Oxford Publication.

Reference Books

1. Management Theory and Practice: P SubbaRao, Himalaya Publishing House
2. Principles of Management: Dr. NeeruVasishth, Taxmann's Publication
3. Management Principles, Processes and Practices: Anil Bhat&Arya Kumar, Oxford Publications
4. Vasanta Desai: Dynamics of entrepreneurial development and management, Himalaya Publishing House
5. Innovation and development: Peter F. Drucker.

Course Code	Exit Course Option				
Course Title	Design and Manufacturing of PCB-With Project				
Scheme and Credits	L	T	P	Credits	Semester
	8	0	0	8	IV

Course Outcome:

End of PCB design training program students will be able to:

1. Identify Electronic Components Symbols & Footprints
2. Design of Schematic, schematic symbol, library using PCB CAD tool.
3. Effective use of design rules & interfacing between schematic & PCB
4. Apply Component placement & routing techniques for various technologies (eg. RF, analog, digital and more)
5. Analyze and Generate various reports & CAM data required for manufacturing & assembly
6. Understand and apply PCB manufacturing process & pre-production engineering

Course Content

Schematic Design and Simulation (08 Hrs)

Getting started with Tools, The Capture work environment, Placing, editing, and connecting parts and electrical symbols, Adding and editing graphics and text, Changing your view of a schematic page, About libraries and parts, Creating and editing parts, About the processing tools, Preparing to create a net list, Creating a net list, Creating reports, Exporting and importing schematic data

PCB Design with CAD tool (17 Hrs)

Creation of netlist, Transfer of netlist to PCB, from schematic to PCB, Parts placement and routing, making footprints, Post Process, Physical PCB construction, PCB Workflow, Footprint generation, Importing, Parts placement, Mechanically defined components, Routing guidelines setting, PCB Construction (Power and Ground Plane), Routing guidelines, Routing, Copper Pour, DRC Checking, From Layout to production, PCB standards.

PCB Fabrication Process (05 Hrs):

Hands-on training on PCB using Photo printing, basic process for double sided PCBs, photo resists, Screen printing. Etching process, Soldering Techniques, Design and test considerations.

Text Book:

Printed circuit board design, fabrication assembly and testing By R. S. Khandpur, Tata McGraw Hill 2006.

Reference Book:

1. Printed Circuit Boards; R S Khandpur; McGraw-Hill Education, 1 edition

2. Allegro PCB Tutorial .

Course Code	BMT2990				
Course Title	Bioinformatics (Open Elective)-II				
Scheme and Credits	L	T	P	Credits	Semester
	2	0	0	2	IV

Course Outcomes

1. Understand the basic principles and concepts of Genomics, Proteomics.
2. Recognise the Advanced concepts and algorithm of sequence alignment and analysis.
3. To Evaluate different algorithms used to analyse Biological data
4. Develop the analytical and experimental skills necessary to understand how bioinformatics data is analysed using softwares.

Syllabus

Module I (6 Hours)

Genomics and sequence analysis- Biomolecular sequence alignment, Dot matrix alignment method, Dynamic programming, Needleman-wunsch algorithm, Smith-waterman algorithm,

Module II (5 hours)

Database Similarity Searches, FASTA, BLAST, Multiple sequence alignment algorithms, CLUSTALW, MUSCLE, DALIGN, T-Coffee, Sequence logos, consensus & patterns, Basic concept of sequence profiles, Derivation of profiles; applications, PSI-BLAST

Module III (5 hours)

Overview of Structural Bioinformatics- Prediction of protein structure, secondary structure prediction methods, First, second and third generation methods, Tertiary structure prediction-Homology modeling, Fold Recognition:1D-3D Profile-based methods.

Module IV (6 Hours)

PCR and Micro Arrays, Software for Biological Data analysis: BLAST, Primer designing software, EMBOSS, ExPasy, Swiss PDBviewer, Rasmol, Gene prediction Software, Galaxy (for big data analysis).

Text Book:

1) Bourne Philip E., Weissig Helge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002

Reference Books:

2) Leach, Andrew. Molecular Modelling: Principles and Applications. Publisher: Prentice Hall. 2001. ISBN: 0582239338.
3) Friesner Richard A. Computational Methods for Protein Folding: advances in Chemical Physics Volume 120 Kindle Edition. Publisher: New York, John Wiley & Sons. 2002. ISBN: 0471209554.
4) Benjamin Lewin, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Genes XIth Edition. Publisher: Kilpatrick Jones & Bartlett Publishers, 2014.

Course Code	BMT5001				
Category	Programme Core Course				
Course Title	Biomechanics				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the Biomechanical Aspects of Human Body.
2. Determine the response behavior of bone subjected to external forces.
3. Correlate the causes (loading) and effects (deformation) of soft tissue based on viscoelasticity.
4. Analyze the fluid flow parameters with elastic vessels.
5. Create a mathematical model for Tissue-implant pair.

Syllabus:

Module I:

Introduction to Biomechanics: Introduction, Newton's law- mechanical behaviour of bodies; Stress, Strain, Elasticity; Hooke's Law; Introduction to biomechanics, work, power and energy relationship – Angular kinematics of human movement-measuring angles, resistance to angular acceleration, angular momentum, center of gravity, stability and balance.

Module II:

Biosolid Mechanics: Bone structure & composition, mechanical and viscoelastic properties of bone– Bone growth and development – Bone response to stress – Osteoporosis – causes, diagnosis, treatment – Elasticity and strength of bone.Mechanical Properties of Bones and Implants; Design Consideration of Stress Shielding, Kinetics and Kinematics of Joints; Lubrication of Joints.

Module III:

Soft Tissue Mechanics: Non-Linear Stress-Strain Relationship; viscoelastic properties of cartilage – Anisotropy and composite models Structure Function and Mechanical Properties of cartilage, Ligaments and Tendons, muscles and skin. Factors affecting muscular force generation – Muscular strength, power and endurance – Muscle injuries.

Module IV:

Biofluid Mechanics: Nature of fluids, Newtonian Fluid; Non- Newtonian Fluid; Viscoelastic Fluids; non-viscous fluid, Rheological properties of blood, Velocity and Pressure of Blood Flow; Propulsion in fluid medium, Resistance Against Flow. Fundamental properties of arterioles, capillary vessels and veins.

Module V:

Cardiovascular Mechanics: Mechanical Properties of Blood Vessels: Arteries, Arterioles, Capillaries and Veins; Function of Cardiac Chambers & Valves; Mechanics of Angiography and Angioplasty; Stent Deployment & Prosthetic Replacement of Cardiac Valves.

Module VI:

Case Studies in Biomechanics: Computational Biomechanics, Tissue material models, Case studies in Biomechanical clinical research, Some Applications of Biomechanics in Qualitative Analysis.

Text Books:

1. Fung, Y.C., 2013. Biomechanics: Mechanical properties of living tissues. Springer Science & Business Media.
2. Hall, S.J. and Lysell, D., 1995. Basic Biomechanics (Vol. 2). St. Louis: Mosby.
3. Knudson, D., 2007. Fundamentals of Biomechanics. Springer Science & Business Media.

Reference Books:

1. Peterson, D.R. and Bronzino, J.D. eds., 2014. Biomechanics: principles and practices. CRC Press.
2. Zamir, M., 2006. The physics of coronary blood flow. Springer Science & Business Media.
3. J. G Webster, "Medical instrumentation –Application & design", John Wiley and Sons Inc., 3 rd edition, 2003.
4. D. J. Schneck and J. D. Bronzino, "Biomechanics- Principles and Applications", CRC Press, 2 nd Edition, 2000.

Course Code	BMT5002				
Category	Programme Core Course				
Course Title	Biomaterials				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course Outcomes

On successful completion of the course, students will be able to:

1. Understand common use of biomaterials as metals, ceramics and polymers and its chemical structure, properties, and morphology.
2. Understand and account for methods for categorization of biomaterials.
3. Explain methods to modify surfaces of biomaterials and choose material for desired biological response.
4. Describe interactions between biomaterials, proteins and cells.
5. Understand the interaction between biomaterial and tissue for short term and long term implantations; distinguish between reactions in blood and in tissue.
6. Explain the types of material used to replace different organs & tissues of human body.

Syllabus

Module I:
Overview of Biomaterials (09 Hrs):

Definition of biomaterials, requirements of biomaterials, classification of biomaterials, Characterization of biomaterials, Biomaterials and their properties. Applications of materials in tissue engineering. Applications of materials in medical device implants.

Module II:
Properties of Biomaterials (09 Hrs):

Bioactivity, biocompatibility and biodegradability. Surface properties and surface characterization of biomaterials. Physicochemical surface modification of materials used in medicine. Surface patterning. Textured and porous materials. Biomimetic materials. Medical fibers. Nanostructured materials – properties, characterization and applications in biomedical engineering.

Module III:
Metals & Non Metals in Biomaterials and Medical Device Implants (09 Hrs):

Ferrous Materials: Iron Materials, Alloy steels like Marogim Steel, Hard Field Steel. Stainless Steel. Tool Steel. Non-ferrous metals.

Polymeric Materials. Carbon fibre reinforced Plastics. Rubbers and Elastomers. Biopolymers. Composite Materials. Ceramics. Refractory materials. Electronic Materials. Metallic glasses – Biometallic ceramics – Cermets – Electrets. SMART Materials, Conducting Polymers.

Module IV:
Host Reactions to Biomaterials (07 Hrs):

Inflammation; Wound healing and the Foreign body response; Systemic toxicity and Hypersensitivity; Blood coagulation and Blood-materials Interactions; Tumorigenesis. Degradation of Materials in Biological Environment: Degradation of Polymers, Metals and Ceramics.

Module V:
Application of Biomaterials (07 Hrs):

Cardiovascular Applications; Dental implants; Adhesives and Sealants; Opthalmologic Applications; Orthopedic Applications; Drug Delivery System; Sutures; Bioelectrodes; Biomedical Sensors and Biosensors.

Text Book:

1. Schoen, F. J., Ratner, B. D., Hoffman, A. S., Lemons, J. E. (2004). Biomaterials Science: An Introduction to Materials in Medicine. Netherlands: Elsevier Science
2. Hench, L. L., Ethridge, E. C. (1982). Biomaterials: an interfacial approach. United Kingdom: Academic Press.
3. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Biomaterials Science: An Introduction to Materials in Medicine, 3, Academic Press, 2012
4. L. Stanciu, S. Diaz-Amaya, Introductory Biomaterials, Academic Press, 2021

Reference Books:

1. Bronzino, J. D. (2000). The Biomedical Engineering Handbook. Germany: CRC Press.

Course Code	BMT5003				
Category	MDM				
Course Title	Healthcare application design using FPGA				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course outcomes:

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

1. Design and analyze combinational, sequential and arithmetic circuits on FPGAs.
2. Understand digital system design flow, timing, synthesis and testability on FPGA.
3. Understand the need of FPGA in healthcare application design
4. Understand the basic concepts of softcore based system design applied to healthcare applications.

Syllabus:

Module I (10 hrs):

Verilog HDL Language Fundamentals and FPGA design flow: Overview of Verilog HDL, FPGA architecture and resources, FPGA Design flow, Design methodologies. Case studies: Case studies on Modelling, Simulation and Synthesis of Combinational and Sequential circuits, Building blocks in FPGA

Module II (08 hrs):

Overview of Back end Processes: Logic partitioning, floor planning, and placement, routing, high level synthesis. Role of FPGAs in Healthcare applications. Diagnostic techniques using FPGA, Real time data analysis using FPGAs.

Module III (07 hrs):

Introduction to soft-core processor and its implementation on FPGA. Introduction to IP Cores and its implementation in FPGA. Introduction to SOC design. Introduction to soft core based SOC design with FPGA. Need for accelerators, Hardware acceleration techniques, Hardware software co-design techniques.

Module IV (10 hrs):

Introduction to Healthcare Solutions from Diagnostics to Clinical in following healthcare application areas with FPGA: Medical Imaging with Ultrasound, Medical Imaging with CT Scanners and MRI Machines, Multi-parameter Patient Monitors & ECGs, Robot-assisted surgery, and Other Medical Equipment. Introduction to build healthcare systems with the highest level of safety, security and reliability with FPGA.

Textbooks:

1. Verilog HDL: A Guide to Digital Design and Synthesis, Samir Palnitkar; Pearson Education; 2nd edition.
2. Rapid System Prototyping with FPGAs: Accelerating the design process: RC Cofer, BenjaminF. Harding, 2005.

Reference Books:

1. Designing with Xilinx® FPGAs: Using Vivado: Springer International Publishing, 2017.
2. Digital System Design with FPGA Implementation Using Verilog and VHDL; CemUnsalan, Yeditepe University, Istanbul, Turkey Bora Tar ; McGraw Hill India.
3. Embedded Microprocessor System Design using FPGAs: Uwe Meyer-Baese, Springer, Year: 2021.

Reference Links:

1. https://www.intel.in/content/www/in/en/healthcareit/products/programmable/overview.html
2. Smart Solutions for Healthcare: Imaging, Diagnostics, and Clinical Equipment https://www.xilinx.com/applications/medical.html

Research Journals:

IEEE, ACM, Elsevier, Springer.

Course Code	BMP5003				
Category	MDM				
Course Title	Healthcare application design using FPGA Lab				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	V

List of practicals:

1) To study the digital system design flow in software tool for simulation, synthesis and implementation.
2) To study the architecture wizard available in Xilinx Vivado Design Suite.
3) To study the IP Core generator wizard.
4) To study the debugging tool in ISE.
5) To study the floor-planning techniques.
6) Introduction to soft-core processor and its implementation on FPGA.

Course Code	BMT5004				
Category	Programme Core Course				
Course Title	Analytical & Diagnostic Equipments				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course Outcomes:

On successful completion of the course, students will be able to:

1. Understand the operating principles of various analytical instruments used in hospital and laboratories.
2. Demonstrate the working of a given analytical equipment.
3. Classify and recommend suitable therapeutic devices for specific applications
4. Analyze different types of therapeutic devices including pediatric applications and support.
5. Suggest the development and modification in the analytical equipment as per recent modifications.

Syllabus:

Module -1 (06 Hrs)

Introduction to Biomedical analytical instruments:
Colorimeter, Spectrophotometer, Biochemical Analyzer, Principles of Electrophoresis apparatus, Principles of Chromatography, Enzyme Linked Immuno Sorbant Assay (ELISA).

Module -2 (06 Hrs)

Pulmonary Function Analyzer, Respiration measurement technique: lung volume and capacities, spirometry, nitrogen washout, helium dilution.

Module -3 (06 Hrs)

Ventilators: Artificial ventilation, ventilator terms and its types, modes of ventilators, classification of ventilators, pressure volume flow and time diagrams. Microprocessor controlled ventilator.

Module -4 (05 Hrs)

Anesthesia Machine: Need for anesthesia, anesthesia machine: gas supply, flow and delivery system vapor delivery and humidification and patient breathing capnography.

Module -5 (05 Hrs)

Hemodialysis machine: Basic principle of dialysis, different types of dialyzer membranes, portable dialyzers and various monitoring circuits.

Module -6 (06 Hrs)

Automated drug delivery systems: Infusion pumps, components of drug infusion systems, syringe and

peristaltic pumps.

Text Book

1. Handbook of Analytical Instruments, Third Edition, R S. Khandpur. McGraw Hill Education (India) Private Limited, New Delhi.
2. Introduction to Biomedical Equipment Technology, Fourth Edition, J.J. Carr and J.M. Brown. (Pearson India Education Services).

Reference Books:

1. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley).
2. Encyclopaedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub).
3. Various Instruments Manuals.

Course Code	BMP5004				
Category	Programme Core Course				
Course Title	Analytical & Diagnostic Equipments Lab				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	V

Course Outcomes

On successful completion of this Laboratory course, students will be able to:

1. Understand the operating principles of various analytical instruments used in hospital and laboratories.
2. Demonstrate the working of a given analytical equipment.
3. Classify and recommend suitable therapeutic devices for specific applications.
4. Analyze different types of therapeutic devices including pediatric applications and support.
5. Suggest the development and modification in the analytical equipment as per recent modifications.

List of Experiments:

Sr. No.	Name of the Experiment
1.	Determine the unknown resistance using a Wheatstone bridge.
2.	Study the input and output characteristics of a Linear Variable
3.	Determine the strain developed in a cantilever beam using half-bridge
4.	Study the principle and working of temperature control using a
5.	Study the use of an ultrasonic sensor as a proximity detector and
6.	Measurement of blood pressure using auscultatory and Oscillometric
7.	Blood pressure measurement using a piezoelectric transducer.
8.	Pulse measurement using a photoelectric transducer.
9.	Study of photoelectric, photovoltaic, and photoconductive transducers.
10.	Mini Project based on sensors.

Course Code	BMT5005-1				
Category	Programme Elective Course				
Course Title	Biostatistics				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course Objective:

The Objective of this course is to expose student to understand the important concepts of Biostatistics. It emphasizes the basic concepts of descriptive statistics and inferential statistics and study of designs. It gives various methods for hypothesis testing. The science of biostatistics encompasses the design of biological experiments, especially in medicine; The collection, summarization, and analysis of data from those experiments; and interpretation of, and inference from, the results.

Course Outcomes:

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

1. Analyze and interpret the data by means of various graphs.
2. Understand the concepts of hypothesis testing as well as the procedures of the various tests of significance applied in Biomedical Sciences.
3. Understand fundamental concepts in multivariate regression analyses.
4. Identify and propose suitable designs to test given hypotheses within biological sciences or related fields.

Syllabus:

Module I:

Introduction to Descriptive Statistics and Sampling Methods:

Sources and presentation of data, methods of presentation, Sampling distribution and sampling methods, Simple random sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling, Multistage Sampling.

Module II:

Test of Significance:

Standard error of the mean and confidence intervals of the mean, Hypothesis Testing, Type I error, Type II error, Power of test, Z-Statistics, Student t Statistics for one sample, for two samples as well as for paired data, Chi squared test of independence, ANOVA method.

Module III:

Correlation and Regression Analysis:

Analysis of Bivariate data: Scatter diagram, correlation Analysis, Types of correlation, Correlation coefficient, Determination coefficient, Linear Regression, multivariate regression analyses.

Module IV:
Study of Designs:
Descriptive studies, Analytical Studies, Observational studies, Cross-sectional study, Cohort study, Case- Control Study, Experimental Studies with examples.

Text Books :

1) Biomedical Statistics -Shantikumar yadav ,Sompal Singh,Ruchika Gupta.

2) Theory and Problems of Probability and Statistics - M.R. Spiegal (Mc Graw Hill) Schaum Series.

Ref. Books :

1) Introduction to Statistics for Biomedical Engineers -Kristina M.Ropella.

2) Probability and Statistics for Engineers -Miller & Freund's, sixth edition Richard A.Johnson.

Course Code	BMP5005-1				
Category	Programme Elective Course				
Course Title	Biostatistics Lab				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	V

Course Objective:

The Objective of this course is to expose student to understand the Practical concepts of Biostatistics. It emphasizes the basic concepts of descriptive statistics and inferential statistics and study of designs. This course will also conduct basic operations in large-scale statistical analyses with statistical software (e.g. MS Excel, Sage math, Open Epi). However, students can use other software packages such as SAS, SPSS, and R (free statistical software).

Course Outcomes:

1. On successful completion of the course, Students will be able to solve.
2. Exercises on graphical visualization of data.
3. Problems on different tests of Significance.
4. Problems on correlation, regression and multivariate regression analyses.

Experiments:

1. Exercise on graphical visualization of data,
2. Problems on Z test
3. Problems on Students t test
4. Problems on Analysis of variance
5. Exercise on Correlation Analysis
6. Exercise on Regression Analysis
7. Exercise on multivariate regression Analysis

Text Books:

1. Introduction to Biostatistical Applications in Health Research with Microsoft Office Excel and R, 2nd Edition by Robert P .Hirsch.

2. Statistics for Health Care Management and Administration: Working with Excel, 3rd Edition by John F.Kros,David A.Rosenthal.

Course Code	BMT5005-2				
Category	Programme Elective Course				
Course Title	Fundamentals of Bio-Sensors				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course Outcomes:

1. Explain the principles, components, and classifications of biosensors.
2. Describe bioreceptor elements and immobilization techniques
3. Analyze transduction mechanisms and signal processing methods.
4. Explore biosensor design, fabrication, and microfabrication techniques
5. Evaluate advanced applications and future trends in biosensor technology.

Syllabus:

Module I:

Introduction to Biosensors: Definition and Historical Background Classification of Biosensors: Electrochemical, Optical, Piezoelectric, Thermal, etc. Basic Components of Biosensors: Bioreceptor, Transducer, and Signal Processor Key Performance Parameters: Sensitivity, Selectivity, Linearity, Response Time, and Stability Applications of Biosensors in Healthcare, Environment, and Food Industry.

Module II:

Bioreceptor Elements and Immobilization Techniques : Types of Bioreceptors: Enzymes, Antibodies, Nucleic Acids, and Cells Bioreceptor-Analyte Interactions: Affinity-based and Catalytic-based Immobilization Techniques: Physical Adsorption, Covalent Bonding, Cross-linking, and Entrapment Impact of Immobilization on Biosensor Performance.

Module III:

Transduction Mechanisms in Biosensors Electrochemical Transducers: Amperometric, Potentiometric, and Conductometric Sensors Optical Transducers: Fluorescence, Surface Plasmon Resonance (SPR), and Fiber Optic Biosensors Piezoelectric Transducers: Quartz Crystal Microbalance (QCM) Thermal Transducers: Calorimetric Sensors Signal Processing and Output Display.

Module IV:

Design and Fabrication of Biosensors: Microfabrication Techniques: Lithography, Etching, and Deposition MEMS/NEMS-Based Biosensors Integration of Biosensors with Microfluidics and Lab-on-a-Chip Systems Challenges in Miniaturization and Mass Production Case Studies: Real-world Biosensor Devices.

Module V:
Advanced Applications and Future Trends:

Wearable Biosensors for Continuous Monitoring, Biosensors for Heavy Metal Ion Detection, Smartphone-Integrated Biosensors and IoT Applications, Artificial Intelligence (AI) and Machine Learning in Biosensor Data Analysis, Emerging Trends: DNA Biosensors, Graphene-Based Biosensors, and Quantum Dot Sensors.

Text books:

1. Biosensors : fundamentals and applications Chandra Mouli Pandey; Bansi D. Malhotra 2019 De,gruyter.

Reference Books :

1. Biosensors: Fundamentals, Emerging Technologies, and Applications Emerging Materials and Technologies Sibel A. Ozkan, Bengi Uslu, Mustafa Kemal Sezgintürk Publisher: CRC Press 2022 ISBN: 9781032038650; 1032038659; 9781032038667
2. Biosensors Nanotechnology, Advanced Material Series Ashutosh Tiwari, Anthony P. F. Turner Wiley-Scrivener 2014 ISBN: 9781118773512; 1118773519
3. Biosensors and modern bio-specific analytical techniques, L. Gorton (ed) Volume XLIV Elsevier 2005.
4. Advances in biosensors, B. D. Malhotra & A. P. F. Turner (eds), Volume 5, Elsevier science 2003.
5. Articles from the journals like, Biosensors, Biosensors and Bioelectronics

Course Code	BMP5005-2				
Category	Programme Elective Course				
Course Title	Fundamentals of Bio-Sensors Lab				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	V

Course Outcomes:

1. Explain biosensor principles, components, and performance parameters.
2. Perform enzyme immobilization and construct electrochemical biosensors.
3. Apply microfabrication techniques in biosensor design.
4. Use sensors for environmental monitoring and AI for data analysis.
5. Develop and test smartphone-integrated biosensors through a mini-project.

Experiment List:

1. Introduction to Biosensors: Demonstrate basic biosensor components and their working principles.
2. Develop and calibrate a pH sensor using electrochemical methods
3. Electrochemical Biosensors: Construction and analysis of amperometric and potentiometric sensors.
4. Immobilization of enzymes using physical adsorption and covalent bonding.
5. Study and calibration of Quartz Crystal Microbalance (QCM) for mass detection.
6. Calorimetric detection methods for biochemical reactions.
7. Hands-on experience with lithography, etching, and deposition techniques.
8. Experiment using GO sensors for environmental detection.
9. AI and machine learning models for biosensor data interpretation.
10. Developing and testing smartphone-connected biosensors for real-time monitoring.
11. Mini project on bio sensing

Course Code	BMT5005-3				
Category	Programme Elective Course				
Course Title	Control Systems				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course Outcomes:

1. Understand the need for mathematical modeling of various systems, representation of systems in block diagrams and signal flow graphs and are introduced to biological control systems
2. Analyze the Time and frequency response characteristics of various systems using different charts
3. Create state models and apply optimum control to a system.
4. Comprehend the application aspects of time and frequency response analysis in physiological control systems.

Syllabus:

Module I: (8 hrs)

Introduction Control Systems: Open and Closed loop Systems, Modeling and Block Diagrams, Block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, Introduction to Physiological control systems- Illustration, Linear models of physiological systems, Difference Between engineering and physiological control system.

Module II: (9 hrs)

TimeResponse:Analysis Step and impulse responses of first order and second order systems, time domain specifications of first and second order systems, steady state error constants, Definition of stability, Routh-Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability.Analytical design for PD, PI,PID control systems.

Module III: (7 hrs)

Frequency ResponseAnalysis: Frequency domain specifications - Polar plots, Bode plots, Nyquist plot, Nyquist stability criterion, closed loop stability, Constant M and N circles, Nichol‘s chart.

Module IV: (5 hrs)

State variable Analysis- Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability, Introduction to Optimal control system.

Module IV: (6 hrs)

Biological System Models: Distributed parameter versus lumped parameter models, Model development of Cardiovascular system- Heart model-circulatory model, Pulmonary mechanics- Lung tissue visco-elastance-chest wall- airways, Interaction of Pulmonary and Cardiovascular models, Simple models of muscle stretch reflex action, Study of steady state analysis of muscle stretch reflex action, Study of transient response analysis of neuromuscular reflex model action, Study of frequency response of circulatory control model

Text Books:

1. I.J. Nagarath and M. Gopal—Control Systems Engineering", Fifth Edition, Anshan Publishers, 2008.
2. Michael CK Khoo, —Physiological Control Systems‖, IEEE Press, Prentice Hall of India, 2005.

Reference Books:

1. Nagoor Kani - Control System Engineering, second edition , RBA 2013
2. John Enderle Susan Blanchard, Joseph Bronzino—Introduction to Biomedical Engineering‖, second edition, Academic Press, 2005.
3. Richard C.Dorf, RoBert H. Bishop,—Modern control systems‖, Pearson,2004.
4. Modern Control Engineering; Katsuhiko Ogata; Prentice Hall, 2010 - Technology & Engineering.
5. M. Gopal, “Control Systems- Principle of Design”, Fourth Edition, 2012, McGrawHill.

Course Code	BMTP5005-3				
Category	Programme Elective Course				
Course Title	Control Systems Lab				
Scheme and Credits	L	T	P	Credits	Semester
	0	0	2	1	V

Course Outcomes:

1. To develop transfer function of various control system plants practically by conducting the experiments.
2. Understand Performance of P, PI and PID Controllers.
3. Analyze the concepts to A.C and D.C position control system.
4. Determine the time response of second order system.
5. Apply the concepts of control systems in developing Program using MATLAB.

Experiment list:

1. Characteristics of D.C. and AC. Servomotors.
2. Frequency response of second order system.
3. Step response of second order system.
4. D.C. Position control system.
5. Performance of P, PI and PID Controller on system response.
6. Design of lag and lead compensation.
7. ON - OFF temperature control systems.
8. Simulation of control system concepts using MATLAB
9. Mini project/Case study on Control Systems

Course Code	BMT5005-4				
Category	Programme Elective Course				
Course Title	Embedded Systems & IoT				
Scheme and Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course Outcome:

After completion of the course, the student will be able to

1. Understand the basics of embedded systems and IoT.
2. Learn about microcontrollers and their programming
3. Interface sensors, actuators, and communication modules.
4. Develop simple IoT-based projects.

Syllabus:

Module 1: Introduction to Embedded Systems & IoT (6 Hours)

Embedded systems basics, components, applications, and an overview of IoT architecture and components.

Module 4: Microcontrollers & Programming (10 Hours)

Introduction to microcontrollers such as Rpi and ESP32, programming and simple sensor interfacing.

Module 3: Sensors, Actuators & Communication (8 Hours)

Understanding different types of sensors and actuators, communication protocols including UART, I2C, SPI, and wireless IoT connectivity using Wi-Fi, Bluetooth, and MQTT.

Module 4: IoT Project Development (5Hours)

Designing and implementing a simple IoT-based project such as a smart home system or weather monitoring application etc.

Text Book:

1. Embedded Systems: Architecture, Programming and Design, Raj Kamal, McGraw-Hill Education.

2.Internet of Things Architecture and Design, Principles, Raj Kamal, Mc Graw hill Education.

Reference Book:

1. Internet of Things Principles and Paradigms, Rajkumar Buyya Amir Vahid Dastjerdi, Morgan Kaufman, Elsevier 2016 1st Edition.

Course Code	BMTH5100				
Category	Honors Course				
Course Title	Programming in Bioinformatics				
Scheme and Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course Outcomes:

1. To study the concept of Database Management System
2. Understand the application of PYTHON in bioinformatics
3. Understand Concept of R in Bioinformatics
4. Apply the programming concept to solve biological problems

Syllabus:

Module I: (7 Hours)

Database designing, data acquisition- Data Abstraction, Data Models, Flat file, relational, network databases, Instances & Schemes, Entity, attributes, E-R Model Entity and entity sets, Relations and relationship sets , E-R diagrams o Reducing E-R Diagrams to tables, Relational Algebra and relational Calculus, Data Normalization.

Module II: (5 Hours)

Introduction to python, COLAB environment, variables and types, strings and manipulation, Relational and logical operators, for Loops, while Loops, tuples, list and dictionaries.

Module III: (9 Hours)

Working with biological data, extraction of data from various sources, Parsing a sequence file, transcribe nucleotide to mRNA, Translate the nucleotide sequence into protein, gene identification, motifs identification, GC percent calculation, deriving sequence logos and Bioinformatics module in BIOPYTHON.

Module IV: (8 hours)

Use of 'R' for biological data processing and data visualization: Introduction to R environment Data types and their properties, Vectors, Factors, Arrays & Matrices, Lists & Data Frames, , Functions , Packages:Standard Packages in R , Analysis of NGS data from R Bioconductor Package.

Module V: (6 Hours)

Data mining and Visualization- Optimization technique, Genetic Algorithm and Ant colony optimization, Introduction to Machine Learning Techniques- Artificial neural networks, Hidden Markov models and Support vector machines, Big Data- Concept, sources and Techniques, Data Visualization.

Textbook:

1. Introduction to Proteomics: Principles and Applications by Nawin Mishra, John Wiley & Sons.
2. Mitchell L Mode., Bioinformatics programming using PYTHON, Orielly, 2010
3. Silberschatz, A, Korth, H F & Sudarshan, S. Database system concepts; McGraw-Hill higher education, 2002. ISBN: 0071148108

Reference Books:

1. Mastering Python for Bioinformatics: How to Write Flexible, Documented, Tested Python Code for Research Computing (Grayscale Indian Edition)
2. Baxevanis A.D., Davison D.B., Page R. D. M. & Petsko G.A. Current Protocols in Bioinformatics. New York, John Wiley & Sons Inc., Latest Edition

Course Code	BMTM5100				
Category	Minor Course				
Course Title	Bioinformatics				
Scheme and Credits	L	T	P	Credits	Semester
	3	0	0	3	V

Course Outcomes:

1. Understand the basic principles and concepts of biology, computer science and mathematics.
2. Know the basic concepts of Genome organization and genes
3. Understand the principles of DNA mapping and Genome sequencing
4. Develop the analytical and experimental skills necessary to understand how bioinformatics data is stored and databases are organized.

Syllabus:

Module I: (7 Hours)

Organization of Prokaryotic and Eukaryotic cells: Cell types; Cell theory; Structure and function of organelles. Cell motility and shape: Cytoskeletal elements, structure, organization and function; Cell cycle: mitosis and meiosis.

Module II: (7 hours)

Genome organization: Prokaryotic and eukaryotic genomes – C value paradox, repetitive and non-repetitive DNA., transposons and retroposons; Exons and introns – organization of interrupted genes, one gene-many proteins concept; Gene numbers – essential genes and total gene number, gene clusters, pseudogenes; Gene families – globin and rDNA gene families; DNA replication, Transcription, Translation, DNA cloning and small RNAs.

Module III (7 Hours)

Genome projects – importance, objectives and strategies Genome markers and mapping: STS, EST, RFLP, SNP. Genome sequencing – First, Second and Next generation sequencing platforms Genome sequence assembly, Output file formats, Quality assessment of sequence reads, Removal of adapter contamination, Reference-guided and de novo Assembly.

Module IV:(7 hours)

Overview of Bioinformatics resources on the web-NCBI/EBI/EXPASY etc., Nature of biological data and formats, Biological literature databases , PubMed, Nucleic acid sequence databases, GenBank, EMBL, DDBJ , RefSeq, dbSTS, dbEST , Protein sequence databases, UniProtKB, Proteomes, NextProt , Derived databases, InterPro and constituent databases, derived databases. RNA sequence databases, miRBase, lncRNAdb, MIT/ICBP siRNA database, Species and Biodiversity databases / resources, NCBI Taxonomy database.

Module V: (7 hours)

Cloning, gene cloning, rDNA technology, Vectors, plasmid, adapter sequences, gene therapy and different techniques.

Textbooks:

1) Mount David W. Bioinformatics: Sequence and Genome Analysis. Publisher: Cold Spring Harbor Laboratory Press; Latest Edition.

Reference Books:

1) Watson James D., Baker Tania A., Bell Stephen P., Alexander Gann, Levine, Michael Losick Richard. Molecular Biology of the Gene 6th Edition. Publisher: New York, Cold Spring Harbor Laboratory Press. 2008. ISBN: 9780321507815.

2) Benjamin Lewin, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Genes XIth
Edition. Publisher: Kilpatrick Jones & Bartlett Publishers, 2014.

3) Nucleic Acids Research - Database issue (Most recent issues relevant to appropriate databases).

4) Baxevanis A.D., Davison D.B., Page R. D. M. & Petsko G.A. Current Protocols in Bioinformatics. New York, John Wiley & Sons Inc., Latest Edition.

5) Date C. J. An Introduction to Database Systems. 1999. Publisher: Addison Wesley.ISBN: 0201327546.

Course Code	BMT3980				
Category	Open Elective				
Course Title	Computational Biology				
Scheme and Credits	L	T	P	Credits	Semester
	2	0	0	2	V

Course Outcomes

1. Understand the basic principles and concepts of Genomics, Proteomics.
2. Recognise the Advanced concepts and algorithm of sequence alignment and analysis.
3. To Evaluate different algorithms used to analyse Biological data
4. Develop the analytical and experimental skills necessary to understand how bioinformatics data is analysed using softwares.

Syllabus

Module I (6 Hours)

Genomics and sequence analysis- Biomolecular sequence alignment, Dot matrix alignment method, Dynamic programming, Needleman-wunsch algorithm, Smith-waterman algorithm,

Module II (5 hours)

Database Similarity Searches, FASTA, BLAST, Multiple sequence alignment algorithms, CLUSTALW, MUSCLE, DALIGN, T-Coffee, Sequence logos, consensus & patterns, Basic concept of sequence profiles, Derivation of profiles; applications, PSI-BLAST.

Module III (5 hours)

Overview of Structural Bioinformatics- Prediction of protein structure, secondary structure prediction methods, First, second and third generation methods, Tertiary structure prediction-Homology modeling, Fold Recognition:1D-3D Profile-based methods.

Module IV (6 Hours)

PCR and Micro Arrays, Software for Biological Data analysis: BLAST, Primer designing software, EMBOSS, ExPasy, Swiss PDBviewer, Rasmol, Gene prediction Software, Galaxy (for big data analysis).

Text Book:

1. Bourne Philip E., Weissig Helge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002.

Reference Books:

1. Leach, Andrew. Molecular Modelling: Principles and Applications. Publisher: Prentice Hall. 2001. ISBN: 0582239338.
2. Friesner Richard A. Computational Methods for Protein Folding: advances in Chemical Physics Volume 120 Kindle Edition. Publisher: New York, John Wiley & Sons. 2002. ISBN: 0471209554.
3. Benjamin Lewin, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Genes XIth Edition. Publisher: Kilpatrick Jones & Bartlett Publishers, 2014.

SYLLABUS OF SEMESTER VI

Course Code	BMT6001				
Category	Programme Core Course				
Course Title	Biomedical Microsystems				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Outcome:

1.Demonstrate the working principles of MEMS and Microsystem and their application in medical field.
2.Explain and evaluate various MEMS fabrication techniques.
3.Analyse Microsensors and Actuators for diagnostics and therapeutic purposes.
4.Design and develop miniaturized biomedical sensors and systems for practical applications.
5.Demonstrate a detailed understanding of the fundamental principles of Microfluidics and their application to biomedical engineering.
6.Apply knowledge of Biomedical Microsystems to identify how they can be exploited for new applications.

Syllabus

Module I:

Introduction to MEMS & BioMEMS: Benefits of Miniaturization, Types of MEMS: Optical MEMS, Bio-MEMS, RF- MEMS, Microfludics, Success Stories, Pressure sensor, Accelerometer, BioMEMS in healthcare.

Module II:

Microfabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining, Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA), MEMS Device fabrication using Bulk Micromachining and surface Micromachaning.

Module III:

Physical Micro sensors and actuators: Classification of physical sensors, Integrated, Intelligent, or Smart sensors, Sensor Principles and Examples: Thermal sensors, Electrical Sensors, Mechanical Sensors Microactuators : Classification of microactuators, Electrostatic, Electromagnetic and Thermal microactuation.

Module IV:

MEMS BIOSENSORS : Bio Sensing Principles and Sensing Methods, Biosensors Arrays and Implantable devices.

Module V:

Microfluidics: Introduction to microfluidics Microscale Behavior of Fluids, Microfluidic Components – Microvalves, Micropumps, Micromixer, and Logic Droplet Microfluidics, Lab on chip, Soft Lithography for microfluidics device fabrication.

Module VI:

Applications of BioMEMS: Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA sensor, MEMS based drug delivery, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor.

Text Books:

1. Micro and Smart Systems: Ananthasuresh, G. K., Vinoy, K. J., Gopalakrishnan, S., Bhat, K. N., and Aatre, V. K., Wiley-India, New Delhi, (1/E) (2010).
2. BioMEMS: Technologies and Applications, Wanjun Wang, Stephen A.Soper, CRC Press, New York, 2007.
3. MEMS and Microsystems Design and Manufacture, Tai Ran Hsu, Tata McGraw Hill Publishing Company, New Delhi, 2002.

Reference Books:

1. Microsensors, MEMS and Smart Devices , Julian W. Gardner , Vijay K. Varadan, Osama O. Awadelkarim, Wiley, (1/E) (2001).
2. VLSI Technology, Sze S.M., Mc Graw Hill, (2/E).

*BMP306-1 (Credit 1) Practical will be based on theory syllabus.

Course Code	BMT6002				
Category	MDM				
Course Title	Biomedical Product and Prototype Design				
Scheme & Credits	L	T	P	Credits	Semester
	2	0	0	2	VI

Course outcomes:

After completion of this course, students will demonstrate the ability to:

1. Visualize the concept of product design and innovations with respect to ergonomics and aesthetics.
2. Analyze, design and draw control panels, front panel and overall enclosure design of biomedical equipment.
3. Understand the design of product architecture, product prototype.
4. Understand the cost of biomedical product design, process of value analysis and standards.

Syllabus:

Module I:

Introduction to product design, Role of industrial design in the domain of industry, Generic product development process, Industrial Design process, product innovations, Introduction to Patents and Intellectual Property Rights, Process for preparing an invention disclosure.

Module II:

Design Development and Planning, Solution Generation and Selection, Product architecture, Product prototypes, Validation and Verification Testing, Testing in Living Systems

Module III:

Electronic product design and development Methodology, Design for Manufacturing, Ergonomics in product design, Aesthetics: Elements of aesthetics, aesthetics of control panel design. Visual Communication Techniques, Value Engineering, Costing and Pricing of Industrial design,0

Module IV:

Medical Device Standards Regulations, and Ethics.
Control/Front panel design of an electronic instrument.
Biomedical Application, Design optimization of Medical Equipment like BP measuring instrument, Pulse Oximeter, Infrared thermometer, Multi-patient monitors, IOT based devices, wearable biomedical devices, etc.

Text Books:

1. Karl T. Ulrich, Steven. D. Eppinger, “Product Design and Development”, McGraw Hill Education.
2. Jospeh Tranquillo, Jay Goldberg, Robert Allen, “Biomedical Engineering Design”, Academic Press, Year: 2022.

Reference Books:

1. Ernest J Mccormick,”Human factors in Engineering and Design” -, McGraw-Hill Co.
2. K.F.H. Murrell, “Ergonomics: Man in his Working Environment”, John Wiley & Sons, New York
3. Stephen J. Guastello, “Human Factor Engineering and Ergonomics, A System Approach” CRC Press
4. Human Factors Design Handbook -Wooden Vs. McGraw Hill New York.
5. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, Third Edition, 2016.

Course Code	BMT6003				
Category	Programme Core Course				
Course Title	Machine Learning for Healthcare				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Outcomes:

On successful completion of the course, students will be able to:

1. Understand fundamentals of various machine learning algorithms and their suitability for different healthcare challenges.
2. Understand how machine learning can be used in specific clinical areas like risk stratification.
3. Understand and analyze disease progression.
4. Learn how to use machine learning for improved diagnosis and disease prediction.

Syllabus:

Module 1: (06 Hrs)

Supervised learning algorithms, unsupervised learning algorithms, Probabilistic Machine Learning Reinforcement Learning: Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Overview of Monte Carlo methods for model free RL.

Module 2: (06 Hrs)

Uniqueness of ML in healthcare and its importance .Electronic Health Record, ML in various task of healthcare- Diagnosis , Prognosis , Treatment , Prevention/Public Health Learning Health Care System, clinical data and its types – Demographics, Vital signs, Medications, Laboratory, Pathology, Microbiology, notes, Quantified Self etc.

Module 3: (06 Hrs)

Risk stratification Framing as supervised learning problem Deriving labels – Evaluation – Subtleties with ML-based risk stratification .Survival modelling, Evaluation for survival modelling Physiological time-series, NLP for Healthcare.

Module 4: (06 Hrs)

Computerized Physician Order Entry (CPOE) ,FDA Approach to Regulating AI-based “devices”, FDA-Approved AI Algorithms for Clinical Applications -OsteoDetect , IDX software , Viz’s, Arterys

Module 5: (06 Hrs)

Differential Diagnosis, Models for Diagnostic Reasoning, Diagnostic Reasoning with Naive Bayes, Evaluation of Diagnostic Systems.

Module 6: (06 Hrs)

Regulatory Aspects and Ethical, Legal, and Societal Implications, :- FDA Regulation of AI/ML Use,Concepts of Ethical and Social Implications of Health AI/ML,Reporting Standards, Certification/Accreditation & Reproducibility.

Text Book:

1) Gyorgy J. Simon, Constantin Aliferis , Artificial Intelligence and Machine Learning in Health Care and Medical Sciences , Best Practices and Pitfalls ,Springer -2024.

2) C. Karthik Chandran , M. Rajalakshmi, Sethu, Sachi Nandan Mohanty, Subrata Chowdhury, Machine Learning for Healthcare Systems Foundations and Applications , River Publishers Series in Computing and Information Science and Technology , September 2023.

Reference Books:

1. The Elements of Statistical Learning Data Mining, Inference, and Prediction by Trevor Hastie, RoBert Tibshirani, Jerome Friedman, 2nd Edition, Springer, 2009.
2. Machine Learning by Mitchell Tom 1st Edition, McGraw Hill, 1997.

Course Code	BMP6003				
Category	Programme Core Course				
Course Title	Machine Learning for Healthcare lab				
Scheme & Credits	L	T	P	Credits	Semester
	0	0	2	1	VI

Course Outcomes:

On successful completion of the course, students will be able to:

1. Understand fundamentals of various machine learning algorithms and their suitability for different healthcare challenges.
2. Understand how machine learning can be used in specific clinical areas like risk stratification.
3. understand and analyze disease progression
4. Learn how to use machine learning for improved diagnosis and disease prediction

Tentative List of experiment for Machine Learning for Healthcare:

1) Load and analyze a sample EHR dataset and Identify different types of clinical data (demographics, vital signs, medications, etc.).
2) Implement a classification model (e.g., logistic regression, decision trees) to predict diseases from patient data.
3) Train a regression model to predict patient survival time or disease progression based on clinical data.
4) Implement a decision tree or random forest model to classify patients into risk categories.
5) Apply Cox Proportional Hazards model or Kaplan-Meier estimator to analyze patient survival data.
6) Work with physiological signals (e.g., ECG data) using LSTMs or other time-series models.
7) Use NLP techniques (e.g., Named Entity Recognition) to extract meaningful insights from clinical notes.

8) Study and replicate key features of OsteoDetect, IDX software, Viz.ai, or Arterys.
9) Implement a simple rule-based decision support system for drug prescriptions.
10) Develop a probabilistic diagnostic model using Naïve Bayes.
11) Implement model validation techniques ensuring reproducibility and adherence to regulatory standards.

Course Code	BMT 6004/BMP6004				
Category	Programme Core Course				
Course Title	Biomedical Image Processing				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	2	4	VI

Course Outcomes:

On successful completion of the course, students will be able to:

1. Apply mathematical tools to obtain basic features from a medical image in time and frequency domain.
2. Implement basic image processing algorithms for image enhancement of medical images.
3. Formulate image restoration model and design filters for noise reduction.
4. Examine segmentation methods on medical images and extract features from medical images.
5. Extract and analyze color and texture features of medical images.
6. Demonstrate proficiency in implementing algorithms and techniques learned in the course through hands-on projects using tools like OpenCV, MATLAB, or Python libraries.

Syllabus

Module 1: Digital Image Fundamentals:

Digital Image Fundamentals: Elements of digital image processing systems; Elements of visual perception, image formation models, sampling and quantization, basic relationships Between pixels, digital image representation, bio medical imaging modalities, mathematical tools used in Digital Image Processing.

Module 2: Biomedical Image Enhancement:

Image Enhancement in spatial domain: Basic gray level transformations, Histogram Processing, Fundamentals of spatial filtering, Smoothing Spatial Filters, Order Statistic Filters, Sharpening Spatial Filters. Image Enhancement in Frequency domain: Basics of filtering in the frequency domain, Image smoothing, sharpening using frequency domain filters.

Module 3: Image Transforms for Biomedical Images:

Two dimensional Orthogonal and Unitary Transforms, Properties of Unitary Transform; 2D Discrete Fourier Transform, Discrete Cosine Transform, Walsh Transform, Hadamard Transform, Haar Transform, KL Transform, Wavelet Transform: CWT, DWT.

Module 4: Medical Image Restoration:

Basic model of image degradation/restoration processes; Types of image blur, linear position-invariant degradation, estimating degradation function, linear and nonlinear image restoration techniques, Inverse filtering, Wiener filtering and restoration in the presence of noise

Module 5: Biomedical Image Segmentation and Feature Extraction:

Detection of discontinuities, edge and boundary detection, Localized feature extraction, Hough transform. Image segmentation: Segmentation using thresholding, Region based segmentation: region growing split and merge techniques. Graph cut algorithm.

Module 6: Color & Texture Based Image Analysis:

Color image processing: Color spaces; Color image demosaicing problem definition, concept of Color Filter Array (CFA)-Bayer pattern, white balancing.

Texture features: structural and statistical, Applications of image processing in medical industries

Text Books

1. R. C. Gonzalez & R. E. Woods, "Digital Image Processing," Pearson education, Fourth edition, 2018.

2. Medical Image Processing Concepts and Applications by G R Sinha & Bhagwati Charan Patel, PHI learning, 2014

Reference Books

1. Digital Image Processing using MATLAB by R. C. Gonzalez, R. E. Woods &Steven Eddins, Pearson education, 2nd Edition, 2017.
2. Feature Extraction and Image Processing for Computer Vision by AlBerto S. Aguado and Mark S. Nixon, Academic Press, 3rd Edition, 2012.
3. Image Processing, Analysis and Machine vision by Milan Sonka, Roger Boyle, and Vaclav Hlavac, Cengage India Private Limited, 4th Edition, 2017.
4. Digital Image processing by S. Jayaraman, S. Esakkirajan, T. Veerakumar, Tata McGraw- Hill Education,15th reprint 2015.
5. Digital Image Processing for Medical Applications by Geoff Dougherty, Cambridge University Press, 1st edition 2009

*BMP 306-2: Practicals will be based on theory syllabus

Course Code	BMT6005-1				
Category	Programme Elective Course				
Course Title	Molecular Biology				
Scheme and Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Objectives

Upon the completion of this course the students will demonstrate the ability to:

1. Understand fundamentals of Molecular Biology.
2. Acquire knowledge on clinical applications of Molecular Biology and Genetic engineering.

Course Outcomes

1. Understand the Concept of Genome Structure and organization.
2. Familiar to the concept of gene, gene families, Genomics and Proteomics.
3. Obtain knowledge of Amplification of DNA and Protein Synthesis.
4. Familiarize with basics of cloning strategies.
5. Obtain knowledge of Detection techniques used for validating cloning strategies in Molecular Biology.
6. Understand Different types of vectors and plasmids used in Genetic Engineering.

Syllabus

Module I (6 Hrs) :

Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA. DNA Replication, Transcription and Protein Synthesis, Genetic Code, Regulation of Protein Synthesis, Post translational Modification.

Module II (5 Hrs):

Gene families, clusters, packaging of chromatins and evolutionary advantage, Organelle genomes, Rearrangement and amplification of DNA in the genome, Polymerase chain reaction, Genomics and proteomics.

Module III (8 Hrs):

Recombinant DNA technology: Restriction and modification enzymes; Vectors - plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, bacterial and yeast artificialchromosomes; Expression vectors; cDNA and genomic DNA library; Gene isolation and cloning, strategies for production of recombinant proteins; Transposons and gene targeting.

Module IV (6 Hrs):

Cloning strategies: Genomic libraries, cDNA libraries, single gene cloning. Vectors in gene cloning: Types of vectors and choice of vectors- Plasmids, cosmids, lamda phage vectors, shuttle vectors, BACs and YACs Choice of hosts, Methods for transferring recombinant DNA to host cells (Transformation and Transfection).

Module V (8 Hrs):

Detection and Characterization of Transformants Screening and selection for transformants: Hybridizations-colony, Southern, Northern, Western, Detection (radioactive and non-radioactive procedures). DNA sequencing techniques including automated DNA sequencing. Site-directed mutagenesis.

Module VI (7 Hrs):

Various expression vectors in bacteria and eukaryotes. Choice of appropriate hosts, Induced expression. Chimeric constructs, Expression of industrially important products.

Text Book

Watson et al. (2014). Molecular Biology of the Gene. 7th Edition

Reference Books

1. Krebs JE, Goldstein ES and Kilpatrick ST. Lewin's Gene XII, Jones and Bartlett.
2. Weaver RF Molecular Biology (2012), 5th Edition, McGraw Hill Higher Education.
3. Trun&Trempy (2004). Fundamentals of Bacterial Genetics. Blackwell. 3rd Edition Alberts et al (2007). Molecular Biology of The Cell. Garland.

Course Code	BMT6005-2				
Course Title	Bionanotechnology				
Category	Program Elective Course				
Scheme and Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Outcomes:

On successful completion of the course, students will be able to:

1. Understand the basic principles nano Science
2. Describe the properties and characterization of nanomaterials
3. Analyze nanomaterial applications in Biological system
4. Apply nano biotechnology in Diagnostics
5. Evaluate bio-nanomaterial toxicity and its implication

Syllabus:

Module 1: (8 Hours)

Fundamental of Nanoscience: The nanoscale dimension and paradigm, Definitions and historical evolution (colloids etc.) and current practices, Types of nanomaterials and their classifications (1D, 2D and 3D etc. Nanocrystal, Nanoparticle, Quantum dot, Quantum Wire and Quantum Well etc).

Module 2: (10 Hours)

Fundamental of Nanomaterial: Polymer, Carbon, Inorganic, Organic and Biomaterials –Structures and characteristics, Physical and Chemical Fundamentals of Nanomaterials Overview of synthetic methods, Surfactants, polymers, emulsions. Micelles/reverse micelles and colloids Top-down and bottom up approaches, Biological Methods, Growth and stabilization, Self-assembly, Introduction to nano material synthesis methods.

Module 3: (8 Hours)

Properties and characterization: Optical (UV-Vis/Fluorescence) –X-ray diffraction – Imaging and size (Electron microscopy, light scattering, Zetapotential)- Surface and composition (ECSA, EDAX, AFM/STM etc) –Vibrational (FT-IR and RAMAN), SERS - Magnetic, Electrical and Electrochemical.

Module 4: (5 Hours)

Applications of Nano-Materials in Biosystems: Proteins - Lipids - RNA and DNA Protein Targeting - Small Molecule/Nanomaterial - Protein Interaction.

Module 5: (5 Hours)

Nanomaterials and Diagnostics/Drug Delivery and Therapeutics: MRI, Imaging Surface Modified Nanoparticles, MEMS/NEMS based on Nanomaterials,: Peptide/DNA Coupled Nanoparticles Lipid Nanoparticles Inorganic Nanoparticles, Drug Delivery, Cyto-toxicity, Geno-toxicity, nanomaterials and toxicity Evaluation etc.

Text Book

1. Bionanotechnology, Principles and Applications- Anil Kumar Anal CRC Press, Taylor & Francis Group, 2018 - Nanobiotechnology - 189 pages 1st Edition.

Reference Books

1. BioNanotechnology Concepts and Applications by Ljiljana Fruk, Antonina Kerbs, Cambridge University Press, 2021.
2. Introduction to Bionenotechnology, Lee Young-Chul by Springer Verlag, Singapore.
3. Bionanotechnology: Engineering Concepts and Applications, by Chen Jie, McGraw-Hill Education.

Course Code	BMT6005-3				
Category	Program Elective Course				
Course Title	Fundamentals of Robotics				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Outcomes

On successful completion of the course, students will be able to:

1. Understand the Basic Concepts of Robotics
2. Analyze Robot Kinematics and Dynamics
3. Develop and Simulate Robotic Systems
4. Analyze Medical Robotic System.

Syllabus:

Module 1: (05 Hrs)
Introduction to Robotics

Definition and origin of robotics, Different types of robotics, various generations of robots, Asimov's law s of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, Robotics market, Degrees of freedom.

Module 2: (6 Hrs)
Kinematics of Robots

Coordinate Frames and Transformations, Forward Kinematics (DH Parameters, Homogeneous Transformations) Inverse Kinematics (Analytical & Numerical Solutions) Jacobian Matrix and Differential Motion Singularities and Redundancy.

Module 3: (06 Hrs)
Robot Dynamics

Newton-Euler and Lagrangian Formulation, Equations of Motion for Robotic Systems Joint Space and Task Space Representation, Dynamic Simulation of Robot.

Module 4: (06 Hrs)
Sensors, Actuators and Robot Control Systems

Sensors - Proximity, Vision, Force/Torque , Actuators- Electric, Hydraulic, Pneumatic , Control of DC Motors and Servo Motors Signal Processing in Robotics Open-loop vs. Closed-loop Control PID Control for Robot Motion Trajectory Planning and Motion Control, Impedance and Admittance Control. Introduction to Model Predictive Control (MPC).

Module 5: (06 Hrs)
Robot Programming and Simulation

Introduction to ROS (Robot Operating System) Programming Robots using Python/C++ ,Simulation Tools: Gazebo, Webot, V-REP Implementing Simple Robot Tasks in Simulation.

Module 6: (04 Hrs)

Introduction to Medical Robotics-

Overview of Robotics in Healthcare Classification of Medical Robots: Surgical, Rehabilitation, Assistive, Diagnostic, Prosthetic etc , Fundamentals of Robot-Assisted Surgery ,Surgical Robotics Systems such as Da Vinci. Specification analysis of Surgical Robotic System.

Text Book:

1. Introduction to robotics by S.K.Saha Mc Graw Hill 2014.
2. Robotics and Control by R Mittle ,I Nagrath Mc Graw Hill 2017.

Reference Books:

1 Achim Schweikard, Medical Robotics, 2015 Springer.

Course Code	BMT6005-4				
Category	Program Elective Course				
Course Title	Object Oriented Programming				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course outcomes:

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

1. Explain the fundamental concepts of Object-Oriented Programming (OOP) such as Abstraction, Encapsulation, Inheritance, and Polymorphism, and **demonstrate** their implementation in Java.
2. Analyze the concept of inheritance, polymorphism, abstract classes, and interfaces to **develop** modular and reusable Java programs.
3. Apply exception handling mechanisms, file handling, and generics in Java to **build** robust and efficient applications.
4. Implement multithreading concepts, including thread creation, synchronization, and inter-thread communication, to **enhance** application performance in Java.
5. Utilize Java collections framework and lambda expressions to develop optimized data management solutions in Java-based applications.

Syllabus:

MODULE I (08 Hrs):

Features of Object-Oriented Programming languages, Abstraction, Encapsulation, Inheritance, polymorphism and late binding, Concept of a class, Access control of members of a class, instantiating a class, constructor and method overloading and overriding.

MODULE II (10 Hrs):

Concept of inheritance, methods of derivation, use of super keyword and final keyword in inheritance, run time polymorphism, abstract classes and methods, Interface, implementation of interface, creating packages, importing packages, static and non-static members, Lambda Expressions Introduction, Block, Passing Lambda expression as Argument.

MODULE III (09 Hrs):

Exceptions, types of exception, use of try catch block, handling multiple exceptions, using finally, throw and throws clause, user defined exceptions, file handling in Java, Serialization, Generics, generic class with two type parameter, bounded generics. Collection classes: Arraylist, Linked List, Hashset, Treeset.

MODULE IV (08 Hrs):

Multithreading: Java Thread models, creating thread using runnable interface and extending Thread, thread priorities, Thread Synchronization, Inter-Thread communications.

Text Books:

1. Herbert Schildt; JAVA, the Complete Reference; Ninth Edition, TataMcGraw- Hill Publishing Company Limited.
2. Design Patterns by Erich Gamma, Pearson Education.

Reference Books:

1. Cay S. Horstmann and Gary Cornell; Core JAVA Volume-II Advanced Features; Eighth Edition; Prentice Hall, Sun Microsystems Press2008.
2. Herbert Schildt and Dale Skrien; Java Fundamentals A Comprehensive Introduction; Tata McGraw Hill Education Private Ltd 2013.

Course Code	BMT6006-1				
Category	Program Elective Course				
Course Title	Advanced Bioinformatics				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Objectives:

1. Understand the basic principles and concepts of Genomics, Proteomics.
2. Know the Advanced concepts and algorithm of sequence alignment and analysis.
3. To understand the concept of algorithm in data analysis.
4. Develop the analytical and experimental skills necessary to understand how bioinformatics data is analysed using softwares.

Syllabus:

Module II: (7 Hours)

Genomics and sequence analysis- Biomolecular sequence alignment, Dot matrix alignment method, Dynamic programming, Needleman-wunsch algorithm, Smith-waterman algorithm, Database Similarity Searches, FASTA, BLAST, Multiple sequence alignment algorithms, CLUSTALW, MUSCLE, DALIGN, T-Coffee, Sequence logos, consensus & patterns, Basic concept of sequence profiles, Derivation of profiles; applications, PSI-BLAST.

Module II: (7 hours)

Overview of Structural Bioinformatics- Prediction of protein structure, secondary structure prediction methods, First, second and third generation methods, Tertiary structure prediction-Homology modeling, Fold Recognition:1D-3D Profile-based methods, Threading methods, ab initio methods, Structural alignments of proteins, Superimposition of structures & calculation of RMSD , Structure-based classification of proteins: SCOP & CATH, Prediction of binding pockets on protein structures, Structure-based function Prediction, Prediction of RNA structures.

Module III: (7 Hours)

Software for Biological Data analysis: BLAST, Primer designing software, EMBOSS, ExPasy, SwissPDBviewer, Rasmol, Gene prediction Software, Galaxy (for big data analysis).

Module IV: (7 hours)

Transcriptomics- Regulation of transcription in prokaryotes and eukaryotes, dynamics in gene expression, Principle and methodology of tools to study comparative gene expression – RT-PCR, qRTPCR, differential display RT-PCR.

Module V: (7 hours)

cDNA micro-array, Northern blotting, Transcriptome analysis- RNA-seq, miRNA-seq, miRNA-micro-array, Computational methods for Transciptome analysis and case studies.

Text Book:

1. Bourne Philip E., Weissig Helge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002.

Reference Books:

1. Leach, Andrew. Molecular Modelling: Principles and Applications. Publisher: Prentice Hall. 2001. ISBN: 0582239338.
2. Friesner Richard A. Computational Methods for Protein Folding: advances in Chemical Physics Volume 120 Kindle Edition. Publisher: New York, John Wiley & Sons. 2002. ISBN: 0471209554.
3. Benjamin Lewin, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Genes XIth Edition. Publisher: Kilpatrick Jones & Bartlett Publishers, 2014.

Course Code	BMT6006-2				
Category	Program Elective Course				
Course Title	Reliability of Medical Equipments				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course outcomes:

On successful completion of the course, students will be able to:

1. Understand fundamentals of reliability and its estimation with respect to healthcare equipment.
2. Apply the various methods for calculation of system reliability.
3. Identify the ways for design and improvement of system reliability, safety and assurance in medical devices.
4. Identify the need of EMI/EMC, medical device standards in reliable design of healthcare instruments.

Syllabus:

MODULE I (08 Hrs):

Introduction to the concept of reliability related to biomedical devices. Reliability and Regulation, Elements of Probability theory, Bays Theorem. Causes of failures, Failure data analysis technique, Mean failure rate, MTTF (Mean Time To Failure), MTBF (Mean Time Between Failure), MTTF in terms of failure density, Reliability in terms of hazard rate and failure density.

MODULE II (10 Hrs):

Reliability modeling, Hazard Models. System Reliability, Mixed configuration, r-out-of-n structure, system not reducible to mix configuration, Logic diagrams. Fault tree analysis, Tie-set and Cut-Set method, Availability and maintainability, reparable system, Instantaneous repair rate, MTTR (Mean Time to Repair).

MODULE III (08 Hrs):

Designing for Reliability, Reliability allocation for a series system, Worst case design consideration. Reliability improvement techniques, Optimization, Reliability-Cost-trade-off, Failure mode and effects analysis (FMEA). Types of testing in reliability, Safety and Risk Management in biomedical instruments.

MODULE IV (09 Hrs): Electromagnetic Compatibility for healthcare equipment, designing for Electromagnetic Compatibility. Sources of Electromagnetic Interface, Noise and Methods of Noise Coupling. Electrostatic Discharge, EMC regulations for healthcare equipment. Medical Device Standards.

Text Books:

1. Richard C. Fries, “Reliable Design of medical devices”, CRC Press, 2013
2. B. S. Dhillon, “Medical Device Reliability and Associated areas”, CRC Press, 2000.
3. Srinath L.S., “Concept in Reliability”, East West Press, 2006.
4. Ott W.H., “Noise reduction techniques in electronic systems”, John Wiley & Sons, 1988.

Reference Books:

1. Fuqua, Marcel Dekker, “Reliability Engineering for Electronic Design”, 1988.
2. Patrick DT O'Connot, “Practical Reliability Engineering” - John Wiley and Sons, 1985.
3. Dr. Gupta A.K.,“Reliability, Maintenance and Safety Engineering”, Laxmi Publications, 2009.

Course Code	BMT6006-3				
Category	Program Elective Course				
Course Title	RTOS and Embedded System				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Outcomes:

On successful completion of the course, students will be able to:

1. Understand the architecture and organization of Cortex microcontroller and its programming.
2. Acquire the knowledge, techniques and skill to integrate microcontroller hardware and software.
3. Analyse the concept of real time operating system architecture.
4. Apply microcontroller-based Embedded system knowledge to real world application.

Syllabus:

Module I: (05 Hrs)

Introduction to embedded System, RISC Principles, ARM Processor Families, AMBA Bus Architecture.

Module II: (06 Hrs)

The Cortex - M processor: Simplified view block diagram, programming model – Registers, Operation modes, Exceptions and Interrupts, Reset Sequence, Instruction Set, Pipeline, Bus, Priority, Vector Tables, Interrupt Inputs and Pending behavior, Fault Exceptions, Supervisor and Pendable Service Call, Nested Vectored Interrupt Controller.

Module III: (06 Hrs)

Introduction to the Cortex microcontroller software interface standard (CMSIS), Interfacing of GPIOs, Timers, ADC, PWM.

Module IV: (06 Hrs)

Communication Protocols: I2C, SPI, UART, MODBUS, USB and its Interfacing with Cortex - M Microcontrollers.

Module V: (06 Hrs)

RTOS Concepts-Critical section, Shared Resources, Context Switching, Pre-emptive and non-pre-emptive Schedulers, Priority Inversion, Mutual exclusion, Synchronization, Inter task communication mechanisms.

Module VI: (06 Hrs)

Structure of µCOS-II: Introduction to µCOS-II-, kernel structure, Task States, Inter task communication, Task Scheduling, Task Synchronization, Critical section, Shared Resources, Context Switching, Priority Inversion, Mutual exclusion. Introduction to embedded Linux.

Text books:

1. The Definitive Guide to the ARM Cortex-M0: Joseph Yiu, Elsevier, (1/E) 2011.

Reference Books:

1. Freescale ARM Cortex-M Embedded Programming, Mazidi and Naimi.
2. ARM An embedded software primer: David E Simon, Pearson education Asia, 2001 Micro C/OS II.
3. The Real Time Kernel: Jean J. Labrosse, CMPBooks,(2/E) 2002.
4. Embedded Linux Primer: christopher Hallinan, Pearson (1/E) 2007.

Course Code	BMT6006-4				
Category	Program Elective course				
Course Title	Telemedicine				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Objective:

1. Execute formal telecommunication technologies to facilitate the deployment of telemedicine.
2. Understand the basic requirements for the delivery of telemedicine services.
3. Differentiate and apply telemedicine technologies and practices in a variety of health care environments.
4. Be aware of basic knowledge of the Telemedicine Standards.
5. The course will also be committed as a public awareness tool to promote and advocate the use of advanced communication technology to expand health care outreach and overcome geographic barriers to deliver patient care and education.

Course Outcomes:

1. Understand the core principles and practices of telemedicine and telehealth.
2. Appreciate the challenges and opportunities associated with digital healthcare.
3. Be prepared to adapt to the rapidly evolving world of telemedicine, ensuring the best care for their patients while integrating practices
4. Distinguish between popular telemedicine uses
5. Develop a telemedicine program

Syllabus:

Module I: (6 Hrs)

TELEMEDICINE AND HEALTH:

History and Evolution of telemedicine, block diagram of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

Module II: (6 Hrs)

TELEMEDICAL TECHNOLOGY:

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, wireless communications Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication, Mobile communication.

Module III: (6 Hrs)

TELEMEDICAL STANDARDS:

Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7, H. 320 series Video Conferencing, Security and confidentiality of medical records, Cyber laws related to telemedicine.

Module IV: (6 Hrs)

MOBILE TELEMEDICINE:

Tele radiology: Image Acquisition system Display system, Tele pathology, Medical information storage and management for telemedicine- patient information, medical history, test reports, medical images, Hospital information system.

Module V: (6 Hrs)
TELEMEDICAL APPLICATIONS:

Telemedicine – health education and selfcare. · Introduction to robotics surgery, Telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Business aspects - Project planning and costing, Usage of telemedicine.

Reference Book

1. Wootton, R., Craig, J., Patterson, V. (Eds.), "Introduction to Telemedicine. Royal Society of Medicine" Press Ltd, Taylor & Francis 2006
2. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), "Public Health Informatics and Information Systems", Springer, 2003.
3. Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54, 2002.
4. Simpson, W. Video over IP. A practical guide to technology and applications. Focal Press Elsevier, 2006.

Text Book:

1. Norris, A.C. "Essentials of Telemedicine and Telecare", Wiley, 2002

Course Code	BMTH6100				
Category	Honors				
Course Title	Computer Aided Drug Design and Chemoinformatics				
Scheme and Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Outcome:

1. Understand the basic principles and concepts of Molecular Docking
2. concepts and analysis of Computer aided drug design
3. Develop the analytical and experimental skills necessary to understand how Chemo informatics data is analysed using software.
4. To understand ADME property of lead compounds.

Syllabus:

Module I: (7 hrs.)

Representation of chemical compounds: 1D, 2D, 3D, SMILES, InChI, Fingerprints (Daylight), Matrices, Connection Tables, mol & sdf files, Markush structures, Rotatable bonds and conformers, Molecular surfaces, Representation of reactions, Searching chemical structures- Exact (Canonicalizing SMILES: Morgan, CANGEN), Substructure, Superstructure and Similarity search.

Module II: (7 hrs.)

Clustering small molecules : Hierarchical and non-hierarchical methods, 3D pharmacophore based searching: Common Pharmacophore features, building hypotheses and searching database, Chemical Databases: CSD, Pubchem, other relevant databases, Quantitative Structure Activity Relationship (QSAR) , Structure descriptors: topological and shape indices, Training and test data set, Applicability domain, 2D QSAR.

Module III: (6 hrs.)

Combinatorial chemistry and Library Design, Historical methods: Mix and Split library design and Iterative deconvolution, Computer based methods, Diversity analysis, Lipinski Rules, Tools for cheminformatics algorithm development.

Module IV: (6 hrs)

Overview of molecular modeling- Potential energy surfaces, Molecular mechanics, Force fields, Molecular Docking, Flexible and Rigid Docking, Concept of free energy, Virtual screening.

Module V: (8 hrs)

History of drug discovery & modern discovery process, Drug vs inhibitor (kinds of inhibitors: competitive, uncompetitive etc), Inhibition constants: IC50, Ki, LD50, Target identification and Validation, Polypharmacology, Sources of small molecules: High throughput screening and molecular libraries initiative, natural and synthetic products, commercial libraries.

Module VI: (7 hrs)

Ligand based: 3D QSAR – Alignment & Non-alignment based, Pharmacophore modeling, Shape based screening, Bioisosteres, Structure based: Virtual screening, Ensemble based screening, De novo methods, Pharmacophores, ADMET & predictions, Pharmacogenomics: pharmacokinetics, pharmacodynamics and case studies of variations in drug response, Success stories of rational design.

Text Books:

1) Hinchliffe Alan. Molecular modelling for beginners. Publisher: John Wiley and Sons Ltd. 2008. ISBN: 978 0470513149.

2) Young David. Computational drug design: A Guide for Computational and Medicinal Chemists. Publisher: Wiley. 2009. ISBN: 9780470126851.

Reference Books:

1) Schlick, T. Molecular modelling and simulation: an interdisciplinary guide. Publisher: Springer. 2002. ISBN: 0-387-95404-X.
2) Hinchliffe Alan. Molecular modelling for beginners. Publisher: John Wiley and Sons Ltd. 2008. ISBN: 978 0470513149.
3) Gasteiger Johann, Engel Thomas. Chemoinformatics: A Textbook. Publisher: Wiley- VCH; 1st edition. 2003. ISBN: 3527306811.
4) Bajorath Jürgen. Chemoinformatics and computational chemical biology. Publisher: Humana Press. 2011. ISBN: 9781607618386.
5) Young David. Computational drug design: A Guide for Computational and Medicinal Chemists. Publisher: Wiley. 2009. ISBN: 9780470126851.
6) Stroud, Robert et al. Computational and Structural Approaches to Drug Discovery: LigandProtein Interactions. Publisher: Royal society of chemistry : Cambridge ISBN: 0854043659.

Course Code	BMTM6100				
Category	Minor				
Course Title	Computational Biology				
Scheme & Credits	L	T	P	Credits	Semester
	3	0	0	3	VI

Course Outcomes:

1. Understand the basic principles and concepts of Genomics, Proteomics.
2. Recognise the Advanced concepts and algorithm of sequence alignment and analysis.
3. To Evaluate different algorithms used to analyse Proteins
4. Develop the analytical and experimental skills necessary to understand how bioinformatics data is analysed using softwares.

Syllabus:

Module I: (6 Hours)

Genomics and sequence analysis- Biomolecular sequence alignment, Dot matrix alignment method, Dynamic programming, Needleman-wunsch algorithm, Smith-waterman algorithm.

Module II: (5 hours)

Database Similarity Searches, FASTA, BLAST, Multiple sequence alignment algorithms, CLUSTALW, MUSCLE, DALIGN, T-Coffee, Sequence logos, consensus & patterns, Basic concept of sequence profiles, Derivation of profiles; applications, PSI-BLAST.

Module III: (5 hours)

Overview of Structural Bioinformatics- Prediction of protein structure, secondary structure prediction methods, First, second and third generation methods, Tertiary structure prediction-Homology modeling, Fold Recognition:1D-3D Profile-based methods.

Module IV: (6 Hours)

PCR and Micro Arrays, Software for Biological Data analysis: BLAST, Primer designing software, EMBOSS, ExPasy, Swiss PDBviewer, Rasmol, Gene prediction Software, Galaxy (for big data analysis).

Module IV: (6 Hours)

Techniques to validate the biological data: Gel Electrophoresis, SDS, 2D PAGE, ELISA, Mass Spectrometry.
Next Generation data analysis using R packages. Concept of protein modelling, Swiss Modeller and Pymol.

Text Book:

1) Bourne Philip E., Weissig Helge. Structural Bioinformatics (Methods of Biochemical Analysis, V. 44), 2003. Publisher: Wiley-Liss. ISBN: 0471202002.

Reference Books:

1. Leach, Andrew. Molecular Modelling: Principles and Applications. Publisher: Prentice Hall. 2001. ISBN: 0582239338.

2. Friesner Richard A. Computational Methods for Protein Folding: advances in Chemical Physics Volume 120 Kindle Edition. Publisher: New York, John Wiley & Sons. 2002. ISBN: 0471209554.

3. Benjamin Lewin, Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Genes XIth Edition. Publisher: Kilpatrick Jones & Bartlett Publishers, 2014.