GALGOTIAS UNIVERSITY

Syllabus of

B.Tech. Biomedical Engineering

Name of School: School of Biomedical Sciences

Department: Biomedical Engineering

Year: 2024-2025

School of Biomedical Sciences

About the School

The School of Biomedical Sciences at Galgotias University stands as a beacon of excellence in the realm of education, research, and innovation. With distinguished faculty members comprising renowned academicians and researchers from across India, the School is committed to nurturing the next generation of leaders in biotechnology, forensic science, and biomedical research.

Under the visionary leadership of Dean Prof. Ranjana Patnaik, an esteemed alumnus of Banaras Hindu University and former Professor at the Indian Institute of Technology (BHU), Varanasi, the School of Biomedical Sciences offers a comprehensive array of programs. The School provides the finest education in diverse domains critical to advancing healthcare and scientific discovery including Biotechnology, Forensic Science, Medical Biotechnology, Clinical Research & Healthcare, Clinical Nutrition & Dietetics and Food Technology.

Our faculty members are not only dedicated educators but also prolific researchers who actively contribute to the global body of knowledge in their respective fields. Through a commitment to cutting-edge research, they publish extensively in prestigious journals, develop patented technologies and organize research seminars to foster knowledge dissemination and exchange. This dedication to research excellence ensures that our students receive an education that is both rigorous and relevant to the evolving demands of the industry.

At the heart of the School of Biomedical Sciences is a vibrant community of over 1100 students, each empowered with deep technical knowledge and practical skills honed in state-of-the-art laboratories equipped with the latest infrastructure and equipment. Beyond classroom learning, students are encouraged to undertake research projects in collaboration with reputed academic institutions and industries, providing them with invaluable real-world experience and fostering a spirit of innovation and entrepreneurship.

The school's commitment to holistic education extends beyond academic pursuits. We believe in nurturing well-rounded individuals equipped with not only technical expertise but also strong ethical values and leadership qualities. To this end, we offer opportunities for extracurricular engagement through dedicated professional societies such as Forensis Agora, Sustainable Innovation and Forensis CyberDost Cell, where students can network, collaborate, and explore their interests beyond the confines of the classroom.

In essence, the School of Biomedical Sciences at Galgotias University is more than just an educational institution; it is a dynamic hub of learning, discovery, and innovation. Through a relentless pursuit of excellence in education and research, we strive to empower our students to become catalysts for positive change in the fields of Biotechnology, Forensic Science, Medical Biotechnology, Clinical Research & Healthcare, Clinical Nutrition & Dietetics and Food Technology, driving innovation and transforming healthcare for the betterment of society.

School of Biomedical Sciences

Vision: To be known globally for value-based education, innovation and multidisciplinary research in Biomedical Sciences, Biotechnology, Forensic Sciences and Criminology.

Mission

M1. Innovate solutions for evolving challenges in biomedical & healthcare sciences, addressing the societal needs effectively.

M2. Cultivate human potential to its zenith, nurturing intellectually adept leaders in healthcare, forensic sciences, and criminology.

M3. Conduct pioneering research to drive innovation in biomedical sciences, biotechnology, Clinical research, forensic sciences, and criminology, fostering collaborations on a national and global scale.

M4. Achieve excellence in education by fostering a dynamic learning environment that embraces diverse interests and talents, equipping students with contemporary knowledge and skills.

Program Educational Objectives (PEO)

PEO 1. Graduates shall conduct the research in healthcare, biomedical science and interdisciplinary field efficiently and ethically.

PEO 2. Graduates of biomedical engineering shall excel in higher studies and interdisciplinary research exhibiting global competitiveness.

PEO 3. Graduates have a high sense of medical responsibilities and ethical thinking and solve new/ unsolved/ unmet biomedical need.

Program Specific Outcomes (PSO)

Graduates of Biomedical Engineering shall be able to

PSO1. Evaluate critical domestic and global regulatory and health care issues that challenge and influence biomedical product development

PSO2. Demonstrate competencies in performing the biomedical research; evaluating, analysing and presenting the biomedical research results.

PSO3. Effectively communicate and collaborate with health care providers and regulatory agencies to develop culturally diverse domestic and global strategies for medical device approvals

PSO4. Demonstrate regulations, social and ethical values required to make a global biomedical research professional.

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Program Outcomes

PO1- Biomedical Engineering Knowledge: Possess knowledge and comprehension of the core and basic knowledge associated with the profession of Biomedical Engineering, including Medical Instrumentation, Biomedical Circuits and Networks, Biomedical Control Systems, Biomaterials and Artificial Organs, Medical signal/image processing and analysis and Virtual Instrumentation Design For Medical Systems.

PO2- Planning Abilities: Demonstrate effective planning abilities including waste management, hospital management, Disaster management, delegation skills and organizational skills. Develop and implement plans and organize work to meet deadlines.

PO3- Problem analysis: Utilize the principles of Analytical thinking, clearly and critically, while solving problems and making decisions during development of medical devices. Find, analyse, evaluate and apply information systematically and making decisions related to biomedical research.

PO4- Modern tool usage: Learn and apply modern and appropriate tools related to biomedical research.

PO5- Leadership skills: Understand and consider the human reaction to change, motivation issues, leadership and team-building when planning changes required for fulfilment of practice, professional and societal responsibilities. Assume participatory roles as responsible citizen s or leadership roles during the conduction of biomedical research to facilitate improvement in health and wellbeing.

PO6- Professional Identity: Understand, analyse and communicate the value of their professional roles in society

PO7- Biomedical Engineering Ethics: Honour human values and apply ethical principles in professional and social contexts. Demonstrate behaviour that recognizes cultural and personal variability in values, communication and lifestyles. Use ethical frameworks; apply ethical principles while making decisions during the conduction of biomedical research.

PO8- Communication: Communicate effectively with the biomedical research & healthcare community.

PO9- Biomedical Engineering and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety and legal issues and the consequent responsibilities relevant to the biomedical research practice.

PO10- Environment and sustainability: Understand the impact of the biomedical research solution in societal and environmental contexts, demonstrate the knowledge of, and need for sustainable development.

PO11- 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. Self-access and use feedback effectively from others to identify learning needs and to satisfy these needs on an ongoing basis.

School of Biomedical Sciences

About Program

The B.Tech. Biomedical Engineering program at the School of Biomedical Sciences, Galgotias University, offers a robust and interdisciplinary curriculum designed to equip students with the knowledge and skills needed to excel in the biomedical engineering field. This four-year program spans eight semesters, blending engineering principles with medical sciences to innovate and improve healthcare solutions.

Students will begin with foundational subjects such as Human Physiology, Engineering Mathematics, and Analog and Digital Electronics. They will delve into specialized courses like Biomedical Circuits and Networks, Medical Instrumentation, and Biomaterials and Artificial Organs, gaining insights into the design and functionality of medical devices. Advanced topics include Biomedical Control Systems, Medical Signal & Image Processing, and Advanced Biomedical Instrumentation, preparing students to handle complex biomedical systems and technologies.

Ethics and Professional Competency, Bioethics and Biosafety, and Hospital and Healthcare Administration courses ensure that graduates are well-versed in the ethical and managerial aspects of the profession. The curriculum also covers cutting-edge areas like Artificial Intelligence & Pattern Recognition, BioMEMS and Biosensors, and Molecular Diagnostics & Therapeutics, fostering innovation and research.

Practical skills are honed through subjects like Virtual Instrumentation Design for Medical Systems, Microprocessors and MicroControllers, and VLSI Design, while research-focused courses such as Research Methodology and Biostatistics prepare students for scientific inquiry and data analysis. Elective options and interdisciplinary subjects like Introduction to Biotechnology and Biomechanics allow students to tailor their education to their interests.

GALGOTIAS UNIVERSITY

School of Biomedical Sciences

Curriculum

Semester I									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	S	IA	MTE	ETE
1	BMET 1001	Chemical and Biological Materials/ Bio-Materials and Implants/ Synthetic Chemistry/ Alternate Energy/ Nano Technology	3	0	0	0	20	30	50
2	BMET 1002	Basic Electrical and Electronics Engineering	3	0	1	0	20	30	50
3	BMET 1003	Programming for Problem Solving	2	0	1	1	20	30	50
4	BMET 1004	Elementary Maths -I	3	0	1	0	20	30	50
5	BMET 1005	Remedial Biology-I	3	0	0	0	20	30	50
6		Engineering Designand Prototyping	3	0	1	0	20	30	50
7		Yoga	0	0	0	0	20	30	50
Total Credits: 22									

Semester II									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	S	IA	MTE	ETE
1	BMET 2001	Introduction to Digital System	2	0	1	0	20	30	50
2	BMET 2002	Environment Impact and Analysis	0	0	0	0	20	30	50
3	BMET 2003	Semiconductor andOptoelectronic Devices/ Modern Physics/Semiconductor Physics/Condensed Matter Physics	3	0	1	0	20	30	50
4	BMET 2004	Communication Skills for Engineers	2	0	1	0	20	30	50
5	BMET 2005	Elementary Maths-II	3	0	1	0	20	30	50
6		Remedial Biology-II	3	0	0	0	20	30	50
7		OOP (Object Oriented Programming)	3	0	1	1	20	30	50
Total Credits: 22									

Semester III									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMET 3001	Human Physiology	3	0	0	3	20	30	50
2	BMET 3002	Medical Instrumentation-I	3	0	0	3	20	30	50
3	BMET 3003	Analog and digital electronics	3	0	0	3	20	30	50
4	BMET 3004	Engineering mathematics	3	0	0	3	20	30	50
5	BMET 3005	Biomedical Circuits and Networks	3	0	0	3	20	30	50
6	SLLL	Ethics and Professional Competency	1	0	0	1	20	30	50
7	BMET 3007/8	Elective-I	3	0	0	3	20	30	50
8	BMEP 3051	Physiology Lab	0	0	2	1	50	--	50
9	BMEP 3052	Bio-electronics Lab	0	0	2	1	50	--	50
10	BMEP 3053	Medical Instrumentation-I Lab	0	0	2	1	50	--	50
11	SOLE	Aptitude building and Logical Reasoning	0	0	2	1	50	--	50

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Semester IV									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	BMET 4001	Biomedical Control Systems	3	0	0	3	20	30	50
2	BMET 4002	Medical Instrumentation-II	3	0	0	3	20	30	50
3	BMET 4003	Biomaterials and Artificial Organs	3	0	0	3	20	30	50
4	BMET 4004	Medical Informatics	3	0	0	3	20	30	50
5	BMET 4005	Data structure using C	3	0	0	3	20	30	50
6	BMET 4006/7	Elective-II	3	0	0	3	20	30	50
7	BMEP 4051	Biomedical Control Systems Lab	0	0	2	1	50	--	50
8	SOLE	Aptitude building and Logical Reasoning	0	0	2	1	50	--	50
9	BMEP 4052	Medical Instrumentation-II Lab	0	0	2	1	50	--	50
10	BMEP 4053	Data structure using C	0	0	2	1	50	--	50
		Total							
Semester V									
Sl No	**Course Code**	**Name of the Course**					**Assessment Pattern**		
			L	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	BMET 5001	Research Methodology and Biostatistics	3	0	0	3	20	30	50
2	BMET 5002	Medical signal & Image processing	3	0	0	3	20	30	50
3	BMET 5003	Tissue Engineering & Microfluidics	3	0	0	3	20	30	50
4	BMET 5004	Bioethics and Biosafety	3	0	0	3	20	30	50
5	BMET 5005	Biopotentials	3	0	0	3	20	30	50
6	BMET 5006/7	Elective-III	3	0	0	3	20	30	50
7	BMEP 5051	Medical signal & Image processing Lab	0	0	2	1	50	--	50
8	BMEP 5052	Molecular Biology and Genetics Lab	0	0	2	1	50	--	50
9	BMEP 5053	Biopotentials Lab	0	0	2	1	50	--	50
10	SOLE	Aptitude building and Logical Reasoning	0	0	2	1	50	--	50
		Total							
Semester VI									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMET 6001	Biophysics & Biochemistry	3	0	0	3	20	30	50
2	BMET 6002	Automation And Quality Control In Biomedical Engineering	3	0	0	3	20	30	50
3	BMET 6004	Virtual Instrumentation Design For Medical Systems	3	0	0	3	20	30	50
4	BMET 6005	Advanced Biomedical Instrumentation	3	0	0	3	20	30	50
5	BMET 6006/7	Elective-IV	3	0	0	3	20	30	50
6	BMEP 6051	Biophysics & Biochemistry Lab	0	0	2	1	50	--	50
7	BMEP 6052	Automation And Quality Control In Biomedical Engineering Lab	0	0	2	1	50	--	50
8	BMEP 6054	Virtual Instrumentation Design and AI Lab	0	0	2	1	50	--	50

9	SOLE	Aptitude building and Logical Reasoning	0	0	2	1	50	--	50
10	BMEP 6055	Campus to corporate/UG Project/ Industrial Training	0	0	6	3	50	--	50
		Total							

Semester VII

Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMET 7001	BioMEMS and Biosensors	3	0	0	3	20	30	50
2	BMET 7002	Artificial Intelligence & Pattern Recognition	3	0	0	3	20	30	50
3	BMET 7003	Modeling of Physiological System	3	0	0	3	20	30	50
4	BMET 7004	Hospital and Healthcare Administration	3	0	0	3	20	30	50
5	BMET 7005	Fundamentals of Clinical Research	3	0	0	3	20	30	50
6	BMET 7006/7	Elective-V	3	0	0	3	20	30	50
7	SLLL	Disaster Management	2	0	0	2	20	30	50
8	BMEP 7051	Artificial Intelligence & Pattern Recognition Lab	0	0	2	1	50	--	50
9	BLE601/ BLE602/BLE603	Foreign Language - 1 (German, Japneese, French) *Compulsory Open Elective	0	0	4	2	50	--	50
		Total							

Semester VIII

Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMEP 8051	Major Project	0	0	24	12	60	--	240

List of Electives

Elective-I

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMET 3007	Electronic Measurement and Instrumentation for Biomedical Applications	3	0	0	3	20	30	50
2	BMET 3008	Introduction to Biotechnology	3	0	0	3	20	30	50

Elective-II

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMET 4006	Biomechanics	3	0	0	3	20	30	50
2	BMET 4007	Microprocessors and MicroControllers	3	0	0	3	20	30	50

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Elective-III

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMET 5006	Linear Integrated Circuits	3	0	0	3	20	30	50
2	BMET 5007	Drug Discovery and Development	3	0	0	3	20	30	50

Elective-IV

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMET 6006	VLSI Design	3	0	0	3	20	30	50
2	BMET 6007	Biotransport Process	3	0	0	3	20	30	50

Elective-V

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BMET 7006	Introduction to Bioinformatics	3	0	0	3	20	30	50
2	BMET 7007	Molecular Diagnostics & Therapeutics	3	0	0	3	20	30	50

NOTE:

The syllabus content is subject to revision based on stakeholder feedback and Academic Requirements.

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Detailed Syllabus

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Semester III

Name of The Course	**Human Physiology**			
Course Code	**BMET 3001**			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the structure and functions of the organ-systems of our own body.

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Circulatory and Lymphatic System
CO2	Understand the Endocrine system & Sensory system
CO3	Understand the Respiratory system
CO4	Understand the Musculo-skeletal System & Urinary system
CO5	Understand about the Nervous system
CO6	Analyse the Digestive system

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Circulatory and Lymphatic System	7 hours
Anatomy of the heart and the blood vessels. Heartposition and function. Origin of the heart beat and electrical activity of the heart. Arteries, capillaries and veins- structure and function. Cardiac and peripheral circulation. Blood pressure and its regulation. Blood flow and its regulation. Circulatory shock. Lymph and dynamics of lymph flow. Blood composition and function. Structure and function of red blood cells, white blood cells and platelets. Blood transfusion. Hemostasis.	
Unit-2: Endocrine system & Sensory system	7 hours
Endocrinology: Endocrine glands: Pituitary gland and hormone, thyroid gland and its hormone, adrenal gland and its hormone function, basic mechanism of hormone action, hormones and diseases. Sensory system: Functional anatomy of eye, ear and nose. Skin	
Unit-3: Respiratory system	7 hours
Anatomical parts of the system and function. Mechanics of respiration. Lung volumes and capacities. Gas transport between the lungs and tissues. Regulation of respiration. Respiratory adjustments in health and diseases;	
Unit-4: Musculo-skeletal System & Urinary system	7 hours
Different types of muscles and their characteristics. Neuro-muscular transmission. Structure of bone. General description of joints and structure. Disorders of: neuromuscular apparatus and joints;	

Various parts, structure and functions of the kidney and urinary tract. Physiology of urine formation and acid base balance. Diseases of the urinary system with reference to drugs used	
Unit-5: Nervous system	7 hours
Functions of different parts of brain and spinal card. Neurohumoral transmission in the central nervous system, reflex action, electroencephalogram, specialized functions of the brain, cranial nerves and their functions; Physiology and functions of the autonomic nervous system. Mechanism of Neurohumoral transmission in ANS	
Unit-6: Digestive system	5 hours
Different parts of the digestive system. Structure and function of these organs. Digestion of proteins, carbohydrates, fats. Basic mechanism of gastrointestinal absorption of nutrients.	

Suggested Readings:

1. Text Book of Medical Physiology, Guyton & Hall, W.B. Saunders company. Hardcourt India Private Limited
2. Ganongs Review of Medical Physiology. K E Barrett, S M Barman, S Boitano, H L Brooks, Tata McGraw Hill Education Private Limited.
3. Vander's Human Physiology: The Mechanisms of Body Function. Eric P. Widmaier, Hershel Raff, Kevin T. Strang. McGraw Hill
4. Ross and Wilson Anatomy and Physiology in Health and Illness by Anne Waugh, Elsevier

Name of The Course	**Medical Instrumentation-I**			
Course Code	**BMET 3002**			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Medical Instrumentations

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Bio Potential Electrodes
CO2	Understand the Electrode Configurations
CO3	Understand the Bio Amplifier
CO4	Understand the Measurement of Non-Electrical Parameter
CO5	Understand about the Bio-Chemical Measurement
CO6	Analyze the Cardiac pacemakers & defibrillators

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Course Contents

Unit-1: Bio Potential Electrodes	7 hours
Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–Skin interface, half cell potential, impedance, polarization effects of electrode –nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.	
Unit-2: Electrode Configurations	7 hours
Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG, ERG and EOG – unipolar and bipolar mode.	
Unit-3: Bio Amplifier	7 hours
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.	
Unit-4: Measurement of Non-Electrical Parameter	7 hours
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.	
Unit-5: Bio-Chemical Measurement	7 hours
Biochemical sensors - pH, pO2 and pCo2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyser (simplified schematic description).	
Unit-6: Cardiac pacemakers & defibrillators	5 hours
Cardiac pacemakers:Classification –External and internal (implantable) pacemakers,Synchronous and asynchronouspacemakers, programmable pacemakers, power sources, Pacing system analyzers. Cardiac defibrillators:Classification–AC and DC defibrillators, Biphasic and Monophasic, Basic principles and comparison of output waveforms of different DC defibrillators, Energy requirements,Synchronous, manual and asynchronous operation, implantable defibrillators, defibrillatoranalyzers, AED.	

Suggested Readings:

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004

2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.

3. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.

4. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.

5. Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGrawHill Publisher, 2003.

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Name of The Course	Analog and digital electronics				
Course Code	BMET 3003				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

Students will understand about the Analog and digital electronics

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Large Signal Amplifiers
CO2	Understand the Multistage Amplifiers
CO3	Understand the Introduction to IC
CO4	Understand the Sequential Circuits
CO5	Understand about the D/A and A/D Converters

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Couse Contents

Unit-1: Large Signal Amplifiers	7 hours
Class A direct coupled with resistive load, Transformer coupled with resistive load, design theory, power amplifier design, harmonic distortion, power output, variation of output power with load, thermal runaway, output transformer saturation, push-pull amplifiers, operation of class-A push-pull amplifier, class-B push-pull amplifier, crossover distortion, class AB push-pull amplifier, transistor phase inverter, conversion efficiency of class B amplifiers, design of Class-B push-pull amplifier, complementary symmetry amplifier.	
Unit-2: Multistage Amplifiers	7 hours
Coupling of transistor amplifiers, frequency response of coupled amplifiers, cascading of RC coupled amplifiers and their analysis. Tuned Amplifiers: single tuned, double tuned and stagger tuned amplifiers and their analysis. Types of feedback, effect of negative feedback on gain, bandwidth, stability, distortion and frequency response etc. Voltage series, current series, voltage shunt, current shunt feedback circuits and their analysis	
Unit-3: Introduction to IC	7 hours
Advantages of IC's, General classification of IC's (Linear/Digital IC's, Monolithic/ Hybrid IC's), Basic IC fabrication step	
Unit-4: Sequential Circuits	7 hours
Introduction, flip flop SR, JK, D, T edge triggered and decked flip-flop, Registers. Type of Registers, circuit diagram, timing wave form and operation counters, counter design with state equation and state diagrams	
Unit-5: D/A Converters	7 hours

Introduction, Weighted register D/A converter, binary ladder D/A converter, steady state accuracy test, D/A accuracy and resolution, Voltage of frequency conversion, Voltage of time conversion. Analog multiplexes and demultiplexes	
Unit-6: A/D Converters hours	5
Parallel A/D converter, Counter type A/D converter Successive approximation A/D converter. Single and dual slope A/D converter A/D accuracy and resolution	

Suggested Readings:

1. Millman and Halkias : Electronic Devices & Circuits, TMH.
2. Boylestad : Electronic Devices & Circuits Theory, PH.
3. Allen Mottorshead : Electronic Devices & Circuits, PHI.
4. Malvino : Digital principle and applications, TMH.
5. R.P.Jain : Modern digital electronics, PIH.
6. Malvino : Digital electronics principle, THM

Name of The Course	Engineering mathematics			
Course Code	BMET 3004			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the coordinate geometry, derivatives, integration, differentiation and differential calculus.

Course Outcomes:

After completion of this course work students able to

CO1	Understand the concept of Coordinate Geometry
CO2	Understand the concept of derivatives on rate of change, functions and variables
CO3	Understand the concept of integration on Curves, Volumes and length
CO4	Understand the concept of differentiation and apply for finding the solution of differential equations.
CO5	Understand about the differential calculus on Kinematics, rate of change, and optimization.
CO6	Analyze the concept of Differentiation rule

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Course contents

Unit-1: Coordinate Geometry	7 hours
Conic Sections: Sections of a cone: circle, ellipse, parabola, hyperbola and pair of intersecting lines. Standard equations and simple properties of parabola, ellipse and hyperbola. Standard equation of a circle, with numerical examples	
Unit-2: Applications of Derivatives	7 hours
Applications of derivatives: rate of change, increasing/decreasing functions, tangents &normals, approximation and errors, maxima and minima of one variable. Simple problems (that illustrate basic principles and understanding of the subject as well as real-life situations).	
Unit-3: Application of integration	7 hours
Areas Between Curves, Volumes, Volumes by Cylindrical Shells, Arc Length	
Unit-4: Differential equation	7 hours
Definition, order and degree, general and particular solutions of a differential equation. Formation of differential equation whose general solution is given. Solution of differential equations by method of separation of variables, homogeneous differential equations of first order, and first degree. Solutions of linear differential equation of the type: , where p and q are functions of x. q py dx dy	
Unit-5: application of differential calculus	7 hours
Kinematics, rate of change, optimization.	
Unit-6: Differentiation rule	5 hours
The Limit of a Function, Calculating Limits Using the Limit Laws, The Precise Definition of a Limit, Continuity, Derivatives of Polynomials and Exponential Functions, The Product and Quotient Rules, Derivatives of Trigonometric Functions, Chain rule, Differentiation of implicit & explicit function , Derivatives of Logarithmic Functions. Roll's and Lagrange's mean value theorem.	

Suggested Readings:

1) Oldham K, Spanier J. The fractional calculus theory and applications of differentiation and integration to arbitrary order. Elsevier; 1974 Sep 5.
2) Eisenhart LP. Coordinate geometry. Courier Corporation; 2005 Mar 4.
3) Grewal BS. Higher engineering mathematics. 2002, Khanna Publishers, New Delhi. 1996.

Name of The Course	Biomedical Circuits and Networks				
Course Code	BMET 3005				
Prerequisite					
Corequisite					
Antirequisite					
	L	T	P	C	
	3	0	0	3	

Course Objectives:

Students will understand about the Biomedical Circuits and Networks

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Resonant & Coupled Circuits
CO2	Understand the Mesh Current & Node Voltage Network Analysis
CO3	Understand the Network Theorems

CO4	Understand the Circuit Transients
CO5	Understand about the Laplace Transform
CO6	Analyse the Graph of Network

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents:

Unit-1: Resonant & Coupled Circuits	7 hours
Resonant Circuits: Series and Parallel Resonance, Impedance and Admittance Characteristics, Quality Factor, Half-Power Points, Bandwidth, Resonant voltage rise, Transform diagrams, Solution of Problems; Coupled Circuits: Magnetic Coupling, polarity of coils, polarity of induced voltage, concept of self and mutual inductance, coefficient of coupling, Solution of Problems	
Unit-2: Mesh Current & Node Voltage Network Analysis	7 hours
Mesh Current Network Analysis: Kirchoff's Voltage Law, Formulation of Mesh Equations, Solution of mesh equations by Cramer's rule and matrix method, Driving point impedance, Transfer impedance, Solutions of Problems with DC and AC sources; Node Voltage Network Analysis: Kirchoff's Current Law, Formulation of node equations and solutions, Driving point admittance, Transfer admittance, Solutions of Problems with DC and AC sources	
Unit-3: Network Theorems	7 hours
Network Theorems: Definition and implications of Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Compensation Theorem, Maximum Power Transfer Theorem, Millman's Theorem, Star-Delta transformations, Solutions and Problems with DC and AC sources; SPICE: Introduction, model statement, elementary DC and small-signal analysis	
Unit-4: Circuit Transients	7 hours
Circuit Transients: DC Transient in R-L & R-C circuits with and without initial charge, R-L-C circuits, AC transients in sinusoidal R-L, R-C, & R-L-C circuits, solution of problems	
Unit-5: Laplace Transform	7 hours
Laplace Transform: Concept of complex frequency, transformation of f(t) into F(s), transformation of step, exponential, overdamped surge, critically damped surge, damped sine, undamped sine functions, properties of Laplace Transform, linearity, real-differentiation, realintegration, Initial Value Theorem and Final Value Theorem, Inverse Laplace Transform, applications in circuit analysis, Partial Fractions expansion, Heaviside's Expansion Theorem, solution of problems	
Unit-6: Graph of Network	5 hours
Graph of Network: Concept of Tree Branch, Tree link, junctions, Incident matrix, Tie-set matrix, Cut-set matrix, determination of loop current and node voltages.	

Suggested Readings:

1. A.B.Carlson-Circuits- Cenage Learning
2. John Bird- Electrical Circuit Theory and Technology- 3/e- Elsevier (Indian Reprint)
3. Skilling H.H.: "Electrical Engineering Circuits", John Wiley & Sons.
4. Edminister J.A.: "Theory & Problems of Electric Circuits", McGraw-Hill Co.
5. Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.
6. R.A.DeCarlo & P.M.Lin- Linear Circuit Analysis- Oxford 7. P.Ramesh Babu- Electrical Circuit Analysis- Scitech

School of Biomedical Sciences

Elective-I

Name of The Course	Electronic Measurement and Instrumentation for Biomedical Applications			
Course Code	BMET 3007			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the basics of sensors and transducers, by which the students can able to know the use and the type of sensors/transducer with other signal conditioning circuit for various biomedical applications.

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Basic concept of measurement system
CO2	Explain the Introduction to instrumentation system
CO3	Understand the Principles of transduction
CO4	Understand the Signal Conditional Circuit
CO5	Understand the Indicating and recording instruments
CO6	Analyse the Introduction of Power electronics devices:

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents:

Unit-1: Basic concept of measurement system	7 hours
Basic concept of measurement system, role of noise and errors in measurement, static characteristics of measuring devices - accuracy, precision, sensitivity, resolution, hysterisis, loading effect etc.	
Unit-2: Introduction to instrumentation system	5 hours
Introduction to instrumentation system, performance characteristics of instrumentation system – system order, specification and testing of dynamic response. Concept of control system, classification, block diagram representation of physical system.	
Unit-3: Principles of transduction	7 hours
Principles of transduction, Resistive Transducers Strain Gauge- types, construction, selection materials, Gauge factor, Bridge circuit, Temperature compensation. Strain Gauge type Blood pressure transducers. Thermo resistive transducer, Pressure transducers – diaphragms, thin film, piezoelectric, force balanced pressure meter. Flow transducers.	

Unit-4: Signal Conditional Circuit	7 hours
Types of filters, frequency transformation, realization of practical filters and its biomedical application.	
Unit-5: Indicating and recording instruments	7 hours
Introduction, digital voltmeters (DVM's), galvanometric recorders, servo type potentiometric recorders, thermal, inkjet, laser recorders, magnetic tape recorders, digital recorder of memory type.	
Unit-6: Introduction of Power electronics devices:	7 hours
Thyristor characteristic and its application as rectifier, as inverter, chopper and cyclo-converters. Other power transistor and IBGT.	

Suggested Readings:

1. Doebelin, Ernest. *System dynamics: modeling, analysis, simulation, design*. CRC Press, 1998
2. Nakra, B. C., and K. K. Chaudhry. *Instrumentation, measurement and analysis*. Tata McGraw-Hill Education, 2003
3. Helfrick, Albert D., and William David Cooper. *Modern electronic instrumentation and measurement techniques*. Prentice Hall, 1990
4. Kalsi, H. S. *Electronic Instrumentation, 3e*. Tata McGraw-Hill Education, 2010

Name of The Course	Introduction to Biotechnology			
Course Code	BMET 3008			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:
The students will be familiarized with Genetics, Molecular Biology, Biotechnology and Immunology.

Course Outcomes

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

CO1	Genetic of Inheritance, interaction between traits and quantitative inheritance
CO2	Molecular Biology, transcription, translation. Mutation and mutagenesis
CO3	Genetic Engineering, vectors & enzymes used in recombinant technology
CO4	Understanding the immunology and vaccine production
CO5	Analyze the red and white biotechnology application
CO6	Analyze the yellow and green biotechnology application

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Course Content:

Unit-1: Genetics	7 hours
Genetics of Inheritance - Laws of inheritance, recombination and segregation of traits, segregation ratio, interaction between traits and quantitative inheritance	
Unit-2: Molecular Biology	7 hours
Molecular Biology - The genetic material. RNA as genetic material, fidelity of DNA replication, transcription, translation. Mutation and mutagenesis.	
Unit-3: Genetic Engineering	7 hours
Genetic Engineering - Essentials of gene manipulation, vectors & enzymes used in recombinant technology.	
Unit-4 : Immunology	7 hours
Active, passive, Humoral and Cellular immunity; Clonal selection theory, Cells of immune system; Immunoglobulins, Haptens, Antigens and Immunogens; Monoclonal antibodies; vaccine	
Unit-5: Application of Biotechnology-I	7 hours
Red biotechnology (Medicine & human health); White biotechnology (Industrial process involving microorganisms)	
Unit-6: Application of Biotechnology-II	5 hours
Yellow biotechnology (Insect Biotechnology in Drug Discovery and Preclinical Research); Green biotechnology (Genetically modified crops)	

Suggested Readings:

1. Elements of Genetics; Phundan singh
2. Genetics: B D Singh
3. A textbook of molecular biology: 3rd edition: Mohan p arora and Himanshu Arora
4. Basic Biotechnology: B D Singh
5. Basic and Clinical Immunology: Mark Peakman and Diego Vergani

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Semester IV

Name of The Course	Biomedical Control Systems			
Course Code	BMET 4001			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Biomedical Control Systems

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Introduction to Physiological control systems
CO2	Understand the Cardiovascular system Modelling and simulation
CO3	Understand the Pulmonary mechanics modeling and simulation
CO4	Understand the Eye movement system and its mathematical model
CO5	Understand about the Simple models of muscle stretch reflex action
CO6	Analyze the Applications of Control theory to physiological systems

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Introduction to Physiological control systems	7 hours
Introduction to Physiological control systems, Illustration, Example of a physiological control system, Difference between engineering and physiological control system, Art of modeling Physiological systems, Linear models of physiological systems, Distributed parameters versus lumped parameter models, Principle of superposition.	
Unit-2: Cardiovascular system Modelling and simulation	7 hours
Cardiovascular system_ Modelling and simulation, Theoretical basis, Model development, Heart model, circulatory model	
Unit-3: Pulmonary mechanics modeling and simulation	7 hours
Pulmonary mechanics modeling and simulation, Theoretical basis, Model development, Lung tissue visco-elastance, chest wall, airways, Full model of respiratory mechanics, Interaction of Pulmonary and Cardiovascular models; Study of frequency domain analysis of linearized model of lungs mechanics,	

Unit-4: Eye movement system and its mathematical model	7 hours
Eye movement system and its mathematical model, oculomotor muscle model, linear muscle model.	
Unit-5: Simple models of muscle stretch reflex action	7 hours
Simple models of muscle stretch reflex action, Ventilator control action, Lung mechanics and their SIMULINK implementation, Study of steady state analysis of muscle stretch reflex action, ventilatory control action by MATLAB tools, Study of transient response analysis of neuromuscular reflex model action by MATLAB tools, Circulatory control model and glucose insulin regulation model by MATLAB tools	
Unit-6: Applications of Control theory to physiological systems	5 hours
Applications of Control theory to physiological systems. Time-domain, frequency domain, stability analysis. Biological performance criteria and adaptive control systems.	

Suggested Readings:

1. “Physiological control systems: Analysis, Simulation and Estimation”, Khoo Michael C.K., Prentice Hall of India Pvt, Ltd, New Delhi

2 “Virtual Bioinstrumentation Biomedical, Clinical and Healthcare applications”, .Olansen Jon B. and Eric Rosow, Prentice Hall PTR, Upper Saddle River, Nj.

3. “Biological Control System analysis”, Milsum John H., McGraw Hill, 1966.

Name of The Course	Medical Instrumentation-II			
Course Code	BMET 4002			
Prerequisite				
Corequisite				
Antirequisite				
L	T	P	C	
3	0	0	3	

Course Objectives:

Students will understand about the Measurement and Recording of Noninvasive Diagnostic Instrumentation, Basic measuring instruments, Patient monitoring system, Biotelemetry & Respiratory Equipments.

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Measurement and Recording of Noninvasive Diagnostic Instrumentation
CO2	Understand the Basic measuring instruments
CO3	Understand the Patient monitoring system
CO4	Understand the Biotelemetry
CO5	Understand about the Audiometers
CO6	Analyse the Respiratory Equipments

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Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Measurement and Recording of Noninvasive Diagnostic Instrumentation	7 hours
Measurement and Recording of Noninvasive Diagnostic Instrumentation, Patient Care and Electrical Safety: Principle of ultrasonic measurement, ultrasonic, thermography, elements of intensive care monitoring,X-ray, CT – Scan and MRI, tonometer, dialysis, diathermy, Shock hazards from electrical equipment.	
Unit-2: Basic measuring instruments	7 hours
Multimeters – analog and digital multimeters. Frequency and time measurement – analog CRO and digital storage oscilloscope. Medical display systems – single and multichannel displays, nonfade displays, LED and LCD displays.	
Unit-3: Patient monitoring system	7 hours
Patient monitoring system–Bed-side monitors, Central station monitors, Computerized arrhythmia monitors, Cardio scope, Ambulatory monitors, Neonatal monitors,Holter monitoring, Infant Warmer, Neonatal Incubator, Infusion pump, syringe pump,Cardiotocograph – Methods of monitoring fetal heart rate	
Unit-4: Biotelemetry	7 hours
Biotelemetry – Principles – Types – Single channel and Multichannel – Frequency division and Time division multiplexing, Telestimulation, Telemedicine – Principles and applications	
Unit-5: Audiometers	7 hours
Audiometers –Pure tone, Speech and Mask audiometers, Bekesy audiometers, Tympanometers. Hearing aids, Cochlear implants, Ear moulds. Densitometers – Principle and applications.	
Unit-6: Respiratory Equipments	5 hours
Respiratory Equipments:Ventilators–Generations–Parameters-Modes of operationsPressure, Flow, volume, cycling, Ventilator terms – ventilator types– Jet ventilators,Humidifier, Nebulizer, Spirometry, Nitric Oxide Therapy,PFT,Plethysmography,Oxymetry –Transmission and Reflection Oxymetry, Fingertip Pulse Oxymeter.	

Suggested Readings:

1. “Principles of Applied Biomedical Instrumentation”,L.A.Geddes &L.E.Baker, Wiley India Pvt.Ltd, Third Edition,1989.

2. “Handbook of Biomedical Instrumentation”,R.S. Khandpur, Second Edition, Tata McGraw Hill, 2003.

3. “Biomedical Instrumentation”,Shakthi Chatterjee& Aubert Miller, CENGAGE Learning, 2010.

4. “Handbook of Biomedical Instrumentation”,Chanderlekha Goswami, Manglam Publications,

2010.

5. “Medical Instrumentation: Application and Design”,John G.Webster, Wiley India Pvt.Ltd, Third Edition, 2002.

6. “CRC Handbook of Clinical Engineering”, B. N. Feinberg, CRC Press, 1980.

7. “The Biomedical Engineering Handbook”,Joseph D. Bronzino, CRC Press, 1995.

Name of The Course	Biomaterials and Artificial Organs			
Course Code	BMET 4003			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Biomaterials and Artificial Organs

Course Outcomes:

After completion of this course work students able to

CO1	Understand the basic concept of biomaterials
CO2	Understand the Biocompatibility & toxicological screening of biomaterials
CO3	Understand the implant materials
CO4	Understand the Orthopaedic Implants & Prosthetic Devices
CO5	Understand about the Cardiovascular Implants and Extracorporeal Devices
CO6	Analyze the Sensory Devices & artificial skins functions

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Introduction to biomaterials	7 hours
Introduction: Definition of biomaterials, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties	
Unit-2: Biocompatibility & toxicological screening of biomaterials	7 hours
Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.	
Unit-3: implant materials	7 hours
Polymeric implant materials, Ceramic implant materials, Composite implant materials, Metallic implant materials	

Unit-4: Orthopaedic Implants & Prosthetic Devices	7 hours
Alveolar bone replacements. Orthopedic implants – types of orthopedic function devices, permanent joint replacements, hip joint, bone cement, Artificial limbs, hand and foot, dental prosthesis	
Unit-5: Cardiovascular Implants and Extracorporeal Devices	7 hours
Blood clotting, Blood Rheology, Heart, Aorta, Valves, Lungs, Vascular Implants, Cardiac Pacemaker, Blood Substitutes, Kidney Function. Artificial kidney, Artificial heart-lung machine	
Unit-6: Sensory Devices & artificial skins	5 hours
Intraocular Lens and hearing aids, artificial skins	

Suggested Readings:

1. “Biomedical Engineering Principles, An Introduction to fluid , heat and mass transfer process”, Cooney D. O., Marcel Dekker Inc, (1976).

2. “Transport Phenomena is living systems- Biomedical Aspects of Momentum and Man Transport”, Lightfoot E. N., John Wiley (1974).

3 “Basic transport phenomena in biomedical engineering”, Fournier, Ronald L., Taylor & Francis, 1998.

Name of The Course	Medical Informatics			
Course Code	BMET 4004			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Medical Informatics

Course Outcomes:

After completion of this course work students able to

CO1	Understand the basic concept of Medical Informatics
CO2	Understand the Computerised Patient Record
CO3	Understand the Computers in Clinical Laboratory and Medical Imaging
CO4	Understand the Computer Assisted Medical Decision-Making
CO5	Understand about the Recent Trends In Medical Informatics
CO6	Analyze the Databases And Computer Network

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks

20	30	50	100

Course Contents

Unit-1: Introduction to Medical Informatics	7 hours
Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and informationSystem, Functional capabilities of a computerized HIS, E-health services, HealthInformatics – Medical Informatics, Bioinformatics	
Unit-2: Computerised Patient Record	7 hours
Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application serverprovider, Clinical information system, computerized prescriptions for patients	
Unit-3: Computers in Clinical Laboratory and Medical Imaging	7 hours
Automated clinical laboratories-Automated methods in hematology, cytology andhistology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine	
Unit-4: Computer Assisted Medical Decision-Making	7 hours
Neuro computers and Artificial Neural Networks application, Expert system –General model of CMD, Computer –assisted decision support system-production rule system cognitive model, semester networks , decisions analysis in clinical medicine-computers in the care of critically patients-computer assisted surgery-designing	
Unit-5: Recent Trends In Medical Informatics	7 hours
irtual reality applications in medicine, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery computer aids for the handicapped, computer assisted Instrumentation in Medical Informatics - Computer assisted patient education and health Medical education and health care information	
Unit-6: Databases And Computer Network	5 hours
Basics of databases- Relational, distributed and other types of databases, Integrity and security of databases, DBMS. Popular databases available in medical related applications. Basics of Computer networks- types and topologies.	

Suggested Readings:

1. R.D.Lele "*Computers in medicine progress in medical informatics"*, Tata McGraw Hill Publishing computers Ltd, 2005, New Delhi.
2. Mohan Bansal, "*Medical informatics"* Tata McGraw Hill Publishing computers Ltd, 2003 New Delhi.

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Name of The Course	Data structure using C			
Course Code	BMET 4005			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Data structure using C

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Data structure Introduction
CO2	Understand the Stacks & , Operations on Queue
CO3	Understand the Tree Traversal algorithms
CO4	Understand the Graphs & algorithm
CO5	Understand about the Searching & Sorting
CO6	Analyze the Search Trees

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Data structure Introduction	7 hours
Introduction: Basic Terminology, Elementary Data Organization, Algorithm, Efficiency of an Algorithm, Time and Space Complexity, Asymptotic notations: Big-Oh, Time-Space trade-off. Abstract Data Types (ADT) Arrays: Definition, Single and Multidimensional Arrays, Representation of Arrays: Row Major Order, and Column Major Order, Application of arrays, Sparse Matrices and their representations. Linked lists: Array Implementation and Dynamic Implementation of Singly Linked Lists, Doubly Linked List, Circularly Linked List, Operations on a Linked List. Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List .	
Unit-2: Stacks & , Operations on Queue	7 hours
Stacks: Abstract Data Type, Primitive Stack operations: Push & Pop, Array and Linked Implementation of Stack in C, Application of stack: Prefix and Postfix Expressions, Evaluation of postfix expression, Recursion, Tower of Hanoi Problem, Simulating Recursion, Principles of recursion, Tail recursion, Removal of recursion Queues, Operations on Queue: Create, Add, Delete,	

Full and Empty, Circular queues, Array and linked implementation of queues in C, Dequeue and Priority Queue.	
Unit-3: Tree Traversal algorithms	7 hours
Trees: Basic terminology, Binary Trees, Binary Tree Representation: Array Representation and Dynamic Representation, Complete Binary Tree, Algebraic Expressions, Extended Binary Trees, Array and Linked Representation of Binary trees, Tree Traversal algorithms: Inorder, Preorder and Postorder, Threaded Binary trees, Traversing Threaded Binary trees, Huffman algorithm.	
Unit-4: Graphs & algorithm	7 hours
Graphs: Terminology, Sequential and linked Representations of Graphs: Adjacency Matrices, Adjacency List, Adjacency Multi list, Graph Traversal : Depth First Search and Breadth First Search, Connected Component, Spanning Trees, Minimum Cost Spanning Trees: Prims and Kruskal algorithm. Transistive Closure and Shortest Path algorithm: Warshal Algorithm and Dijikstra Algorithm, Introduction to Activity Networks	
Unit-5: Searching & Sorting	7 hours
Searching : Sequential search, Binary Search, Comparison and Analysis Internal Sorting: Insertion Sort, Selection, Bubble Sort, Quick Sort, Two Way Merge Sort, Heap Sort, Radix Sort, Practical consideration for Internal Sorting.	
Unit-6: Search Trees	5 hours
Search Trees: Binary Search Trees(BST), Insertion and Deletion in BST, Complexity of Search Algorithm, AVL trees, Introduction to m-way Search Trees, B Trees & B+ Trees . Hashing: Hash Function, Collision Resolution Strategies Storage Management: Garbage Collection and Compaction.	

Suggested Readings:

1. Aaron M. Tenenbaum,YedidyahLangsam and Moshe J. Augenstein “Data Structures Using C and C++”, PHI Learning Private Limited, Delhi India

2. Horowitz and Sahani, “Fundamentals of Data Structures”, Galgotia Publications Pvt Ltd Delhi India.

3. A.K. Sharma ,Data Structure Using C, Pearson Education India.

4. Rajesh K. Shukla, “Data Structure Using C and C++” Wiley Dreamtech Publication.

5. Lipschutz, “Data Structures” Schaum’s Outline Series, Tata Mcgraw-hill Education (India) Pvt. Ltd

6. Michael T. Goodrich, Roberto Tamassia, David M. Mount “Data Structures and Algorithms in C++”, Wiley India

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Elective-II

Name of The Course	Biomechanics			
Course Code	BMET 4006			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Biomechanics

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Introduction to Fluid Mechanism
CO2	Understand the Flow Analysis of Velocity and Pressure Gradient
CO3	Understand the Flow Dynamical Study of Circulating System
CO4	Understand the Soft Tissue & Lungs Mechanics
CO5	Understand about the Orthopaedic Mechanics
CO6	Analyze the Cochlear Mechanics

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Introduction to Fluid Mechanism	7 hours
asic laws governing conservation of mass, Newton's Law, Hooke's Law, momentum and energy, laminar flow, Newtonian and Non-Newtonian Fluid, Viscoelastic fluid, Couette flow and Hagen-Poiseville equation, turbulent flow.	
Unit-2: Flow Analysis of Velocity and Pressure Gradient	7 hours
Arterial impedance relating pulse pressure and flow rate, mechanism and transport in microcirculation, microcirculatory flow, Transcapillary fluid movements in systemic circulation, physiological factors controlling blood pressure, Heart valves.	
Unit-3: Flow Dynamical Study of Circulating System	7 hours
Heart and blood vessels, Ventricular pressure, volume, ECG time based cyclic variation. Determination of ventricular wall diastolic, systolic modules verses stress properties and their physiological connotation, Intra-ventricular blood	

Unit-4: Soft Tissue & Lungs Mechanics	7 hours
Pseudo-elasticity, Nonlinear stress- strain relationship, Structural and functional properties of skin, ligaments and tendon, Muscle in terms of its elastic and contractile element parameters; Lung structure and function, methods of determining lung pressure and volume, airway resistance and conductance	
Unit-5: Orthopaedic Mechanics	7 hours
Mechanical properties of Cartilage, Diffusion properties of articular cartilage, Mechanical properties of bone, Kinetics and kinematics of joint, Lubrication of joints, Analysis of force in orthopaedic implants	
Unit-6: Cochlear Mechanics	5 hours
Passive Models, Active Models, Vestibular Mechanics, Otolith Distributed Parameter model, Non- Dimensionalisation of the Motion Equation, Otolith Transfer Function and Frequency Response, Semicircular Canal Distributed Parameter model and its Frequency Response	

Suggested Readings:

1. Y.C. Fung : Biomechanics –Circulation, Springer Verlag, 1997.

2. Susan J. Hall : Basic Biomechanics l, TMH, 2002.

3. Ozkay & Margareta Nordin: Fundamentals of Biomechanics, Springer Verlag, 1999.

4. Y.C. Fung :Biomechanics-Mechanical Properties of Living tissues, Springer Verlag, 1981

5. Dawson and Right :Introduction to biomechanics of joints and joint replacement, Mechanical Engg. Publication Ltd. 1989.

6. Jacob Kline :Handbook of Biomedical Engineering, Academic Press Inc. 1988

Name of The Course	Microprocessors and MicroControllers				
Course Code	BMET 4007				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

Students will understand about the Microprocessors and MicroControllers

Course Outcomes:

After completion of this course work students able to

CO1	Understand the 8086 Architecture
CO2	Understand the Instruction Set and Assembly Language Programming of 8086
CO3	Understand the I/O Interface & Communication Interface
CO4	Understand the Interfacing with advanced devices

CO5	Understand about the Introduction to Microcontrollers
CO6	Analyze the The AVR RISC microcontroller architecture

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: 8086 Architecture	7 hours
Introduction to 8085 Microprocessor, 8086 Architecture-Functional diagram. Register Organization, Memory Segmentation. Programming Mode!. Memory addresses. Physical memory organization. Architecture of 8086, signal descriptions of 8086- common function signals. Minimum and Maximum mode signals. Timing diagrams. Interrupts of 8086.	
Unit-2: Instruction Set and Assembly Language Programming of 8086	7 hours
Instruction formats, addressing modes, instruction set, assembler directives, macros, simple programs involving logical, branch and call instructions, sorting, evaluating arithmetic expressions, string manipulations	
Unit-3: I/O Interface & Communication Interface	7 hours
8255 PPI various modes of operation and interfacing to 8086. Interfacing keyboard, display, stepper motor interfacing, D/A and A/D converter; Serial communication standards, Serial data transfer schemes. 8251 USART architecture and interfacing. RS- 232. IEEE-4-88, Prototyping and trouble shooting	
Unit-4: Interfacing with advanced devices	7 hours
Memory interfacing to 8086, Interrupt structure of 8086, Vector interrupt table, Interrupt service routine. Introduction to DOS and BIOS interrupts, Interfacing Interrupt Controller 8259 DMA Controller 8257 to 8086.	
Unit-5: Introduction to Microcontrollers & 8051 Real Time Control	7 hours
Overview of 8051 microcontroller. Architecture. I/O Ports. Memory organization, addressing modes and instruction set of 8051, simple program; Interrupts, timer/ Counter and serial communication, programming Timer Interrupts, programming external hardware interrupts, programming the serial communication interrupts, programming 8051 timers and counter	
Unit-6: The AVR RISC microcontroller architecture	5 hours
Introduction, AVR Family architecture, Register File, The ALU. Memory access and Instruction execution. I/O memory. EEPROM. I/O ports. Timers. UART. Interrupt Structure	

Suggested Readings:

1. D. V. Hall. Micro processors and Interfacing, TMGH. 2'1 edition 2006.

2. Kenneth. J. Ayala. The 8051 microcontroller , 3rd edition, Cengage learning, 2010

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Semester V

Name of The Course	Research Methodology & Biostatistics			
Course Code	BMET 5001			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	4	0	0	4

Course Objectives:

Students will get exposure about Research Methodology & Biostatistics

Course Outcomes:

After completion of this course work students able to

CO1	Understand about the basic concepts of Research
CO2	Understand about the Research Design
CO3	Understand about the Research Report and ethics
CO4	Understand about the Sampling methods
CO5	Understand about the Measures of central tendency
CO6	Understand about Hypothesis testing

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Content:

Unit-1: Introduction to Research	8 hours
Research definition, types, advantage and significance. Introduction to research methods, identifying research problem, definition, objectives, role, scope in biotech research, process of research, limitations & types	
Unit-2: Research Design	7 hours
Concept of Interdisciplinary Research, Procedures in research. Types of Research Design: Experimental/Interventional research, Quasi-experimental studies, Observational research. Sources of Experimental Errors. Survey research: Types of surveys- CATI, CAPI, Mail, Email, Face-to-face, Questionnaire	
Unit-3: Research Report and ethics	5 hours
Type of research report- Research, review, case report, manuscript, monograph, book chapters. Structure of Research Reports. Quoting of reference and bibliography using reference management tools. Ethical issues in research, plagiarism.	

Unit-4: Sampling methods	5 hours
Sampling methods, Advantages and Limitation, Sampling process, Types of Sampling, Probability and Non Probability sampling techniques, sampling errors, Data collection Primary and secondary data, Collection and validation.	
Unit-5: Measures of central tendency	8 hours
Measures of central tendency- Mean, Median, Mode; Measures of dispersion- Range, Mean deviation and Coefficient of variation, Standard deviation, Standard error; Correlation and regression; Statistical inference- Hypothesis testing, Significance level, Confidence interval, t-test, z-test. Test of significance for large and small samples; Parametric tests; Non parametric tests; Experimental design, Use of biostatistic softwares.	
Unit-6: Hypothesis testing	7 hours
Null hypothesis and test of significance (t-test, paired t-test, Analysis of variance, Analysis of covariance, Coefficient of Variation, chi-square test, Fischer exact, Mann-Whitney, Wilcoxin, McNeman test, Kruskal Wallis.	

Suggested Readings:

1. Graziano AM, Raulin ML. Research methods: A process of inquiry. HarperCollins College Publishers; 1993.
2. C.R. Kothari : Research Methodology, New Age International Publishers
3. Bouma GD, Ling R, Wilkinson L. The research process. Oxford: Oxford University Press; 1993 Mar 30.
4. Dawson B, Trapp RG. Basic and clinical biostatistics. Singapore. 2004;2001:141-2

Name of The Course	Medical signal & Image processing			
Course Code	BMET 5002			
Prerequisite				
Corequisite				
Antirequisite				
L	T	P	C	
3	0	0	3	

Course Objectives:

Students will understand about the Medical signal & Image processing

Course Outcomes:

After completion of this course work students able to

CO1	Understand the
CO2	Understand the Biomedical Signals
CO3	Understand the Fundamentals of Deterministic Signal Processing
CO4	Understand the Fundamentals of Deterministic Image Processing
CO5	Understand about the Probability and Random Signals
CO6	Analyze the Image Segmentation and Registration

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Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Biomedical Signals	7 hours
ECG: Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications. Speech Signals: The source-filter model of speech production, spectrographic analysis of speech. Speech Coding: Analysis-synthesis systems, channel vocoders, linear prediction of speech, linear prediction vocoders.	
Unit-2: Biomedical Image	7 hours
Imaging Modalities: Survey of major modalities for medical imaging: ultrasound, X-ray, CT, MRI, PET, and SPECT. MRI: Physics and signal processing for magnetic resonance imaging. Surgical Applications: A survey of surgical applications of medical image processing.	
Unit-3: Fundamentals of Deterministic Signal Processing	7 hours
Data Acquisition: Sampling in time, aliasing, interpolation, and quantization. Digital Filtering: Difference equations, FIR and IIR filters, basic properties of discrete-time systems, convolution. DTFT: The discrete-time Fourier transform and its properties. FIR filter design using windows. DFT: The discrete Fourier transform and its properties, the fast Fourier transform (FFT), the overlap-save algorithm, digital filtering of continuous-time signals.	
Unit-4: Fundamentals of Deterministic Image Processing	7 hours
Sampling Revisited: Sampling and aliasing in time and frequency, spectral analysis. Image processing I: Extension of filtering and Fourier methods to 2-D signals and systems. Image processing II: Interpolation, noise reduction methods, edge detection, homomorphic filtering.	
Unit-5: Probability and Random Signals	7 hours
PDFs: Introduction to random variables and probability density functions (PDFs). Classification: Bayes' rule, detection, statistical classification. Estimating PDFs: Practical techniques for estimating PDFs from real data. Random signals I: Time averages, ensemble averages, autocorrelation functions, crosscorrelation functions. Random signals II: Random signals and linear systems, power spectra, cross spectra, Wiener filters. Blind source separation: Use of principal component analysis (PCA) and independent component analysis (ICA) for filtering	
Unit-6: Image Segmentation and Registration	5 hours
Image Segmentation: statistical classification, morphological operators, connected components. Image Registration I: Rigid and non-rigid transformations, objective functions. Image Registration II: Joint entropy, optimization methods.	

Suggested Readings:

1. Quatieri, T. F. Discrete-Time Speech Signal Processing: Principles and Practice. Upper Saddle River, NJ: Prentice-Hall, 2001. ISBN: 9780132429429.
2. Lim, J. S. Two-Dimensional Signal and Image Processing. Upper Saddle River, NJ: Prentice Hall, 1989. ISBN: 9780139353222.
3. Gonzalez, R., and R. E. Woods. Digital Image Processing. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 2002. ISBN: 9780201180756.

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Name of The Course	Tissue Engineering & Microfluidics				
Course Code	BMET 5003				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

Students will understand about the Tissue Engineering & Microfluidics

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Introduction to tissue engineering
CO2	Understand the Cell-extracellular matrix interactions
CO3	Understand the Cell and tissue culture
CO4	Understand the tissue engineering case studies
CO5	Understand about the Microfabrication techniques
CO6	Analyze the Microfluidics components

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Introduction to tissue engineering	5 hours
Cells as therapeutic Agents with examples, Cell numbers and growth rates. Tissue organization, Tissue Components, Tissue types, Functional subunits. Tissue Dynamics, Dynamic states of tissues, Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis.	
Unit-2: Cell-extracellular matrix interactions	5 hours
Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell-Cell contact - Cell junctions in tissues, malfunctions in direct cell-cell contact signaling. Response to mechanical stimuli.	
Unit-3: Cell and tissue culture	6 hours
Cell and tissue culture - types of tissue culture, media, culture environment and maintenance of cells in vitro, cryopreservation; Basis for Cell Separation, characterization of cell separation, methods of cell separation.	
Unit-4: tissue engineering case studies	7 hours
Bioreactors for Tissue Engineering.; In vivo cell & tissue engineering case studies: Artificial skin, Artificial blood vessels. In vivo cell & tissue engineering case studies: Artificial pancreas, Artificial liver. Regeneration of bone, muscle. Nerve regeneration.	
Unit-5: Microfabrication techniques	7 hours

Materials, Clean room,Silicon crystallography, Miller indices. Oxidation, photolithography- mask, spin coating, exposure and development,Etching,Bulk and Surface micromachining, Wafer bonding. Polymer microfabrication,PMMA/COC/PDMS substrates, micromolding, hot embossing, fluidic interconnections.	
Unit-6: Microfluidics components	10 hours
Micropumps, Check-valve pumps,Valve-less pumps,Peristaltic pumps, Rotary pumps, Centrifugal pumps, Ultrasonic pump, EHD pump, MHD pumps. Microvalves,Pneumatic valves, Thermopneumatic valves, Thermomechanical valves,Piezoelectric valves,Electrostatic valves,Electromagnetic valves, Capillary force valves. Microflow sensors, Differential pressure flow sensors, Drag force flow sensors, Lift force flow sensors, Coriolis flow sensors, Thermal flow sensors. Micromixers,Physics of mixing,Pe-Re diagram of micromixers, Parallel lamination,Sequential lamination, Taylor-Aris dispersion. Droplet generators,Kinetics of a droplet, Dynamics of a droplet, In-channel dispensers, T-junction and Cross-junction, Droplet formation, breakup and transport. Microparticle separator, principles of separation and sorting of microparticles, design and applications. Microreactors, Design considerations, Liquid-phase reactors, PCR, Design consideration for PCR reactors	

Suggested Readings:

1. Nguyen, N. T., Werely,S. T., Fundamentals and applications of Microfluidics,Artech house Inc., 2002.
2. Bruus, H., Theoretical Microfluidics, Oxford University Press Inc., 2008.
3. Madou, M. J., Fundamentals of Microfabrication, CRC press, 2002.
4. Tabeling,P., Introduction to microfluidics, Oxford University Press Inc., 2005
5. Kirby,B.J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices,Cambridge University Press, 2010.
6. Colin,S., Microfluidics, John Wiley & Sons, 2009.

Name of The Course	Bioethics and Biosafety			
Course Code	BMET 5004			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:
To understand the Bioethics and Biosafety

Course Outcomes

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

CO1	Understand the Conceptual foundations of biomedical ethics
CO2	Analyze the Ethics in health care
CO3	Examine the Ethical dimensions of GMO & Bioweapons

CO4	Understand the Biosafety regulations and competent authorities
CO5	Analyze the Principles and components of containment
CO6	Examine the Operational Guides on Containment

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Content

Unit-1 Conceptual foundations of biomedical ethics 7 hours
Principlism; Deontology; Consequentialism/Utilitarianism; Communitarianism; Virtue ethics; Ethics of Care; Human Rights
Unit-2 Ethics in health care 7 hours
Ethical dimensions of palliative care and end-of-life care; Reproductive health ethics; Ethical issues in global health; Ethics and the pharmaceutical industry; Ethical issues in rural health care
Unit-3 Ethical dimensions of GMO & Bioweapons 7 hours
Ethical dimensions of genetic and genome-based research; Ethical dimensions of research involving bioweapons; Ethics in gene therapy, germ line, somatic, embryonic and adult stem cell research.
Unit-4 Biosafety regulations and competent authorities 7 hours
Recombinant DNA Advisory Committee (RDAC); Review Committee on Genetic Manipulation (RCGM); Institutional Biosafety Committee (IBSC); Genetic Engineering Appraisal Committee (GEAC); State Biotechnology Co-ordination Committee (SBCC); District Level Committee (DLC)
Unit -5 Principles and components of containment 5 hours
Factors in Containment: Physical Containment; Biological Containment; Laboratory Monitoring; Health and Medical Surveillance; Decontamination and Disposal; Emergency Procedures;
Unit -6 Operational Guides on Containment 7 hours
Microbiological Biosafety Level (BSL) Facilities; Containment For Large Scale Operations Of Genetically Engineered (GE) Microorganisms; Animal Biosafety Level Facilities; Containment requirement for import, export and exchange

Suggested Readings:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi

2. Bioethics and Biosafety- M.K. Sateesh

3. Bioethics and Biosafety- Rajmohan

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Name of The Course	Biopotentials				
Course Code	BMET 5005				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:
To impart the complete knowledge of Electrophysiology which forms the base of Bioinstrumentation i.e. how Bioelectric signals are generated, propagated, transduced, amplified and recorded. Proper recording of the bioelectric signals help in diagnosis of the diseases.

Course Outcomes

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

CO1	Understanding of bioelectric phenomena
CO2	Understanding of Interaction of signals
CO3	Understanding of Electrical circuit model of the membrane
CO4	Analyze the ECG EMG and EEG
CO5	Examine the Central nervous system and neuro-control mechanisms
CO6	Analyze the Receptors as biological transducers

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Content:

Unit-1: Introduction to bioelectric phenomena 7 hours
Bioelectric phenomena, Neurons and Synapse; Generation, Transmission and Propagation of signals in nervous systems – Resting Potential, Action Potential, Synaptic Potential.
Unit-2: Interaction of signals 7 hours
EPSP (Excitatory Post Synaptic Potentials) and IPSP (Inhibitory Post Synaptic Potentials); Interaction of signals to control various functions and reflexes of body.
Unit-3: Electrical circuit model of the membrane 7 hours
Electrical circuit model of the bio-membrane, The Laws of stimulation and conduction of nerve impulse.
Unit-4 : ECG EMG and EEG 7 hours
Electrocardiography (ECG) and its diagnostic applications– Generation and propagation of cardiac impulse, SA node as Pacemaker, Ectopic Pacemakers, PQRST Wave Pattern. Various cardiographic leads (Limb leads, Chest leads), Vectorial analysis of normal and diseased heart Electrophysiological signals- EMG, Brain potentials and their generation, Propagation, recording and diagnostic applications.
Unit-5: Central nervous system and neuro-control mechanisms 7 hours
Nervous system, Neuro-Anatomy in brief, Neural circuits for processing information, Central Nervous System, Peripheral Nervous System, Ventricle and Cerebrospinal Fluid, Neuro control Mechanisms

Unit-6 Receptors as biological transducers	5 hours
Receptors as biological transducers, Transduction and Amplification in receptors, Properties of receptors.	

Suggested Readings:

1. Introduction to Neurobiophysics, Vasilescu, S.G. Margineanu, Abascus Press, Tunbridge Wells, Vent.
2. Text Book of Medical Physiology, Guyton A.C. and J.E. Hall, Harcourt India Pvt. Ltd.
3. Anatomy and Physiology, Ross and Wilson, Churchill Livingstone.

Elective-III

Name of The Course	Linear Integrated Circuits			
Course Code	BMET 5006			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Linear Integrated Circuits

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Integrated Circuits
CO2	Understand the Operation Amplifier
CO3	Understand the OP-AMP APPLICATIONS
CO4	Understand the Active Filters, Oscillators And Regulators
CO5	Understand about the TIMERS & PHASE LOCKED LOOPS
CO6	Analyze the D-A AND A- D CONVERTERS

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Course Contents

Unit-1: Integrated Circuits	7 hours
Classification, chip size and circuit complexity, Fundamentals of Monolithic IC technology, basic planar processes, Fabrication of a typical circuit, Active and passive components of ICs, fabrication of FET, Thin and thick film technology.	
Unit-2: Operation Amplifier	7 hours
Basic information of Op-amp, ideal and practical Op-amp, Op-amp characteristics, 741 op-amp and its features, modes of operation-inverting, noninverting, differential mode	
Unit-3: OP-AMP APPLICATIONS	7 hours
Basic application of Op-amp, instrumentation amplifier, ac amplifier, V to I and I to V converters, Precision rectifiers, log and antilog amplifiers, sample & hold circuits, multipliers and dividers, Differentiators and Integrators, Comparators, Schmitt trigger, Multivibrator, Triangular wave generator.	
Unit-4: Active Filters, Oscillators And Regulators	7 hours
Introduction-Low pass and High pass filters- Design of first and second order Butterworth lowpass and high pass filters Band pass, Band reject and all pass filters- Oscillator types and principle of operation – RC, Wien bridge oscillators triangular, saw-tooth, square wave and VCO- Introduction to voltage regulators, features of 723, Three Terminal IC regulators- DC to DC Converter-Switching Regulators-UPS-SMPS.	
Unit-5: Timers & Phase Locked Loops	7 hours
Introduction to 555 timer, functional diagram, monostable and astable operations and applications, Schmitt Trigger. PLL - introduction, block schematic, principles and description of individual blocks of 565-PLL applications, Analog and digital phase detectors.	
Unit-6: D-A AND A- D CONVERTERS	5 hours
Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, Different types of ADCs - parallel comparator type ADC, counter type ADC, successive approximation ADC, dual slope ADC and Sigma delta ADC. DAC and ADC specifications. DAC 0800 and ADC 0804 pin diagram and applications	

Suggested Readings:

1. D. Roy Chowdhury, "Linear Integrated Circuits" New Age International (p) Ltd, 2nd Ed., 2003.
2. R.F. Coughlin & Fredrick F. Driscoll. Operational Amplifiers & Linear Integrated Circuits, PHI, 6th Edition, 2003
3. Ramakanth A. Gayakwad, Op-Amps & Linear ICs –PHI, 4th Edition 2004.

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Name of The Course	Drug Discovery and Development				
Course Code	BMET 5007				
Prerequisite					
Corequisite					
Antirequisite					
	L	T	P	C	
	3	0	0	3	

Course Objectives:

Students will get exposure about Drug Discovery and Development

Course Outcomes:

After completion of this course work students able to

CO1	Understand about the basic concepts of Drug Discovery and Development
CO2	Understand about the Pre-Clinical Studies
CO3	Understand about Bioassays
CO4	Understand about the Drug designing
CO5	Understand about the Methods and Process of Drug discovery
CO6	Understand about the Non Clinical Drug Development

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Content:

Unit-1: Introduction to Drug development	7 hours
Need for a new Drug, Target identification, lead identification, Sources of new drugs: synthetic, natural, endogenous, peptides; compounds for screening as a potential drug, Drug Discovery & Drug development process. In vivo, in vitro and in silico studies. Animal models of diseases.	
Unit-2: Pre-Clinical Studies	7 hours
Importance of Pre-Clinical studies, Steps involved in Pre-clinical studies, Types of Pre-Clinical Studies, Introduction to toxicology, Organ specific toxicity, Toxicity Studies.	
Unit-3: Bioassays	
Bioassays; Biochemical, Molecular, Behavioural & Physiological parameter analysis, Pharmacokinetics, Pharmacology, Pharmacodynemics, Tissue distribution study	
Unit-4: Drug designing	7 hours
Drug design-Ligand based, Structure based, target-centered drug design: DNA, RNA and Protein based drug designing, Structure Activity Relationship (SAR), Quantitative Structure Activity Relationship (QSAR), Computer assisted drug designing (CADD)	
Unit-5: Methods and Process of Drug discovery	7 hours
High Through Put Screening (HTS): Introduction, Advantages and Disadvantages, Uses, Methodology; Combinatorial Chemistry, methods and processes; Lead optimization techniques	
Unit-6: Non Clinical Drug Development	5 hours
GLP, GMP, GCP; submission of IND, NDA, ANDA	

Suggested Readings

1 Preclinical Drug Development, Edited by Mark Rogge, David R. Taft, Second Edition, 25th Sep 2009.
2 Hill RG. Drug Discovery and Development-E-Book: Technology in Transition. Elsevier Health Sciences; 2012 Jul 20.
3 Choudhary MI, Thomsen WJ. Bioassay techniques for drug development. CRC Press; 2001 Oct 4.
4 Klebe G. Drug Design: Methodology, concepts, and mode-of-action. Heidelberg, Germany: Springer; 2013 Jul 10.
5 Armstrong JD, Hubbard RE, Farrell T, Maiguashca B, editors. Structure-based drug discovery: an overview. Royal Society of Chemistry; 2006

Semester VI

Name of The Course	Biophysics & Biochemistry			
Course Code	BMET 6001			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Biophysics & Biochemistry

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Biological principles
CO2	Understand the Bioelectricity
CO3	Understand the Electrical stimulus & Biophysical activity
CO4	Understand the Radioactivity
CO5	Understand about the Macromolecules
CO6	Analyze the Enzymes and Nucleic acids

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Biological principles	7 hours
Composition & properties of the cell membrane, membrane transports, permeability Coefficient & partition coefficient, body fluids, electrolytes, acid-base balance, blood viscosity and Newtonian nature, colloids, filtration, diffusion, osmosis, dialysis, ultrafiltration, ultracentrifugation, cellular fractionation, electrophoresis, plasmapherosis, radioimmunoassay, Photochemical reaction, law of photochemistry, fluorescence and phosphorescence	
Unit-2: Bioelectricity	7 hours
Membrane Potential, Local and propagator types, Diffusion potential, phase boundary potentials, Generator Potentials, compound Action Potentials (AP), Propagation of AP, factors influencing propagation of AP, biosignal and types, Electrical properties of excitable membranes, Membrane Capacitance, Resistance, conductance, dielectric properties of membrane, space and time constant for excitable membrane, equivalent electrical circuit diagram for excitable membranes and neural membranes	
Unit-3: Electrical stimulus & Biophysical activity	7 hours
Stimuli, Receptor potential, pacemaker potential, strengthduration relationship, skin impedance, total body impedance, impedances at high frequencies, patient safety, electrical shock and hazards, leakage current, different wave forms & their characteristics. waveform and significance,	
Unit-4: Radioactivity	7 hours
Ionizing radiations, U-V & I-R radiations, Production of radioisotopes & their use in biomedical research, Radioactive decays, Half life period, Linear Energy Transfers (LET), Relative Biological Efficiency (RBE) and Interaction of radiation with-matter	
Unit-5: Macromolecules	7 hours
Classification and functions of carbohydrates, glycolysis, TCA cycle, ATP sysnthesis, Blood Sugar analysis and glucose tolerance test, Classification and functions of proteins, architecture of proteins, Classification of amino acids, Oxidative and non oxidative deamination, transamination, decarboxylation, urea cycle, Purification/separation of proteins, Classification and functions of lipids, biosynthesis of long chain fatty acids, oxidation and degradation of fatty acids.	
Unit-6: Enzymes and Nucleic acids	5 hours
Chemical nature and broad classification of enzymes, M-M-Kinetics, Isozymes and Allosteric enzymes, Isolation techniques, Structure of DNA, Genetic code, Recombinant DNA, Transcription & Translation, Reverse Transcription, Replication.	

Suggested Readings:

1. Radiation Biophysics, Second Edition - by Edward L. Alpen - Academic Press; 2 edition

2. Bio-Physics – Roland Glaser- Springer; 2nd printing edition (November 23, 2004)

3. Text book of Medical Physiology- Guyton

4. The Biomedical Engineering Hand Book- 3rd Ed- (Biomedical Engineering Fundamentals) - Joseph D.Bronzino – CRC –Tylor-Francis – 2006 (Section- III – Bio-Electrical Phenomena)

5. Lehninger Principles of Biochemistry, Fourth Edition - by David L. Nelson & Michael M.Cox , - W. H.Freeman; 4 edition (April 23, 2004)

6. Fundamentals of Biochemistry: Life at the Molecular Level - by Donald J. Voet , Judith G. Voet & Charlotte W. Pratt. - Wiley; 2 edition (March 31, 2005)

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Name of The Course	Automation And Quality Control In Biomedical Engineering			
Course Code	BMET 6002			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Automation and Quality Control in Biomedical Engineering

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Robotic Surgery
CO2	Understand the Mobile Robotics
CO3	Understand the Advanced Robotics systems
CO4	Understand the Biomedical Applications of Medical Robotics
CO5	Understand about the Quality Control
CO6	Analyze the Need for Standardization

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Robotic Surgery	7 hours
Surgical Robots – Types, Advances and Applications. Technologies involved in Robotic Surgery – Sensors, Actuators, Micromechanics, Communication control, Virtual Reality and Artificial Intelligence. Application of Intelligent tools for Robotic systems design, Integration of Electronics and Communication systems with Human nerve network.	
Unit-2: Mobile Robotics	7 hours
Architecture of Advanced Mobile Robotics, Actuator design, Navigation, Obstacle avoidance, Sensors and Vision systems. Legged Robotic devices, Control of Mobile Robots in Semi structured environment	
Unit-3: Advanced Robotics systems	7 hours
Control, Instrumentation – Navigation – Route planning –Autonomous operation – Haptic interface – Haptic feedback in systems design – System Architecture – Data fusion – System integration, Advances in Micromechatronics. Robotic systems: Robotic Radio surgery system, Computer assisted surgery and Rehabilitation Robotics in Virtual environment	
Unit-4: Biomedical Applications of Medical Robotics	7 hours
Nerve cell repair using Micromechatronics, Micro and Nanodevices for targeted delivery of medicines to tumour sites and diagnosis using navigable biosensors, Surgeries performed using robotic systems– Mitral valve Surgery and minimally invasive surgeries, Surgical procedures in	

General surgery, Neurology, Urology, Gastroenterology, Cardiology, Orthopedics, Pediatrics and Radio surgery	
Unit-5: Quality Control	7 hours
Quality control tools, Problem solving methodologies, New Management Tools, Quality policy development, Quality function development, designing for Quality, Manufacturing for Quality	
Unit-6: Need for Standardization	5 hours
Regional, National, International Standardization, Methods for Testing Standardization, Maintenance of Standardization & Recalibration, Food and Drug Administration Regulations	

Suggested Readings:

1. *"Advanced Robotics and Intelligent Machines",* J.O.Roy, Darwin G.Caldwell, D.G.Campbell, Institution of Electrical Engineers, 1996.
2. *"Computer Vision, Virtual Reality and Robotics in Medicine",* Nicholas Ayache Springer-Verlag, 1993.
3. *"Robotics Research",* Raymond A.Jarvis, Alexander Zelinsky Springer, 2003.
4. *"Embedded Robotics",* Thomas Braunl Springer, 2003.
5. *"Sensor Based Intelligent Robots",* Gregory D.Hager, H.I.Christensen, Horst Bunke, Rolf Klein Springer, 2002.
6. *"Primer of Robotic and Telerobotic Surgery",* Garth H.Ballantyne, Jacques Marescaux, Pier Cristoforo Giulianotti Williams & Wilkins, 2004.

Name of The Course	Virtual Instrumentation Design For Medical Systems			
Course Code	BMET 6004			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Virtual Instrumentation Design For Medical Systems

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Review of Virtual Instrumentation
CO2	Understand the G Programming
CO3	Understand the Programming Structure & Techniques
CO4	Understand the Hardware Overview
CO5	Understand about the Data Acquisition Basics
CO6	Analyze the principle of Analysis Tools

Continuous Assessment Pattern

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Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Review of Virtual Instrumentation	7 hours
General functional description of a digital instrument - block diagram of a virtual instrument - physical quantities and analog interfaces - hardware and software - user interfaces - advantages of virtual instrumentation over conventional instruments - architecture of a virtual instrument and its relation to the operating system. LabVIEW: Basic arithmetic operations, Boolean operations	
Unit-2: G Programming	7 hours
Software environment - palettes - data types and colour coding - editing, debugging and running a VI - data flow programming - modular programming - loops - local and global variables. LabVIEW: Sum of 'n' numbers using 'for' loop, 'While'loop.	
Unit-3: Programming Structure & Techniques	7 hours
Programming Techniques: VIS and sub-VIS loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Graphical programming in data flow, comparison with conventional programming. Arrays and clusters - sequence structures - plotting data - making decisions in a vi - strings and File I/O - semaphores - TCP/IP - shared variables - data publishing - state machines LabVIEW: Array maximum and minimum	
Unit-4: Hardware Overview & Common Instrument Interfaces	7 hours
PC architecture: current trends - operating system requirement drivers - interface buses - PCI, PXI and USB buses - interface cards: specifications LabVIEW: Application using formula node; Current loop, RS.232C/RS.485, GPIB, System buses, interface buses: USB, PCMCIA, VXI, SCXI, PXI, etc., networking basics for office &.Industrial applications, Visa and lVI, image acquisition and processing. Motion control. ADC, DAC, DIO, DMM, waveform generator.	
Unit-5: Data Acquisition Basics	7 hours
ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation. GPIB/IEEE 488 concepts, and embedded system buses - PCI, EISA, CPCI, and USB & VXI. A; Classification of signals - analog and digital interfacing - DAQ hardware and software - configuring the hardware - ADC, DAC, Digital I/O, counters and timers - advanced triggering of audio and video signals - basic system components of a signal conditioning system. LabVIEW: Instrumentation of an amplifier to acquire an ECG signal using NI vision acquisition software	
Unit-6: Use of Analysis Tools	5 hours
Fourier transforms, power spectrum correlation methods, windowing & filtering, Major equipments- Oscilloscope, Digital Multimeter, Pentium Computers, Application in Biomedical field.	

Suggested Readings:

1. Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2000. Lab VIEW Basics I &II Manual, National Instruments, 2005. Barry E Paton, "Sensors, Transducers & LabVIEW", Prentice Hall of India, New Delhi, 1999

2. Johnson G, Jennings R, "LabVIEW Graphical Programming", Tata McGraw Hill, New York, 2006. Sanjay Gupta, Joseph John, "Virtual Instrumentation using LabVIEW", Tata McGraw Hill, New Delhi, 2010.

Name of The Course	Advanced Biomedical Instrumentation			
Course Code	BMET 6005			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Advanced Biomedical Instrumentation

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Physics of fiber optics
CO2	Understand the Laser in biology
CO3	Understand the Lasers in surgery
CO4	Understand the biomedical Lasers
CO5	Understand about the Digital Imaging and Communications in Medicine
CO6	Analyze the

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Physics of fiber optics	7 hours
Introductory physics of fiber optics, properties, Generation, transmission and detection of fiber optics - Fiber optics in diagnosis - Transmission of signals, light, and construction details of optical fiber, types of medical fiber optic scopes – Fiber optic sensors for temperature, pressure, liquid level, Doppler probe - Fiber optics endoscopy for various organs	
Unit-2: Laser in biology	7 hours
Laser in biology: Optical properties of tissue, Pathology of laser reaction in skin, thermal effects, laser irradiation, Non thermal reactions of laser energy in tissue, effect of adjuvant.	
Unit-3: Lasers in surgery	7 hours

Lasers in surgery: Surgical instrumentation of CO2, Ruby, Nd-YAG, He-Ne, Argon ion, Qswitched operations, continuous wave, Quasi – continuous, surgical applications of these lasers. Lasers in dermatology, lasers in ophthalmology, laser photocoagulations, laser in dentistry.	
Unit-4: biomedical Lasers	7 hours
Speckle intereferometry, holography - Application Safety with biomedical Lasers. Basic principles of Multicolor lasers, plastic imaging multifibers, Intravascular pressure transducers and in vivo oximeters & Virtual reality assisted surgery planning	
Unit-5: Digital Imaging and Communications in Medicine	7 hours
Digital Imaging and Communications in Medicine (DICOM) – data formats – services. Picture archiving and communication system (PACS) – architecture – Integration with Hospital information system (HIS) and Radiology Information System (RIS) – Digital Radiography	
Unit-6: Biodevices	5 hours
ESWL - Smart pacemakers - Minimally invasive robotic surgery - Drug encapsulation - Gene Therapy – Molecular scans - Real time imaging of the Coronary Arteries – Nanomaterials - Smart textiles - Electroactive fabrics and wearable biomonitoring devices – the Bionic person – Nanomotors	

Suggested Readings:

1. Ronald W. Waynant, Lasers In Medicine, Taylor & Francis Ltd CRC Press Inc, Hardcover – 2001 (UNITS I, II)

2. Abraham Katzir, Lasers and Optical Fibers in Medicine, Academic Press, Oct-1993 (UNIT III)

3. H. K. Huang, PACS: Basic Principles and Applications (Paperback), Wiley-Liss; 1 edition November, 1998. (UNIT IV)

4. Joseph D Bronzino, The Biomedical Engineering Handbook, CRC Press, Third Edition – Volume II & III (UNIT V)

School of Biomedical Sciences

Elective-IV

Name of The Course	VLSI Design				
Course Code	BMET 6006				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:

Students will understand about the VLSI Design

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Introduction to IC Technology
CO2	Understand the VHDL basics
CO3	Understand the Component declarations
CO4	Understand the Concurrent statements
CO5	Understand about the VHDL synthesis
CO6	Analyze the Design of Arithmetic Building Blocks and Subsystem

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Introduction to IC Technology	7 hours
Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & BiCMOS technologiesPass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design-Gate realization using CMOS-Introduction to Reconfigurable Hardware – HDL basics.	
Unit-2: VHDL basics	7 hours
VHDL basics - VHDL levels of abstraction - Abstraction and timing - The VHDL design flow - VHDL design entities - Entity declarations - Architectures - Using libraries and packages - Concurrent signal assignments - Signal assignments with delays	
Unit-3: Component declarations	7 hours
Component declarations - Component instantiation - Named port mapping - Positional port mapping - Direct instantiation - Configuration specifications - Entity binding Port modes - VHDL processes - Processes sensitivity lists - Objects in VHDL - Constants, variables and signals - VHDL types - Scalar types - Arrays – Records - Custom types and subtypes	
Unit-4: Concurrent statements	7 hours

Concurrent statements - Sequential statements - Conditional & selective signal assignments - The generate statement - Signal and variable assignments - For loops - Subprograms – Functions – Procedures - Differences between functions and procedures - Subprogram declarations – Packages - Package declaration - Package body.	
Unit-5: VHDL synthesis	7 hours
VHDL synthesis - Modeling hardware in VHDL - VHDL models for multiplexers, Encoders, Decoders, Parity Generators – combinational circuit implementation - compilation and simulation of VHDL code, modeling a sequential machine, Test bench development.	
Unit-6: Design of Arithmetic Building Blocks and Subsystem	5 hours
Arithmetic Building Blocks: Data Paths, Adders, Multipliers, Shifters, ALUs, power and speed tradeoffs, Case Study: Design as a tradeoff.Designing Memory and Array structures: Memory Architectures and Building Blocks, Memory Core, Memory Peripheral Circuitry.	

Suggested Readings:

1. Chip Design for Submicron VLSI: CMOS Layout & Simulation, - John P. Uyemura, Thomson Learning.

2. Introduction to VLSI Circuits and Systems - John .P. Uyemura, JohnWiley, 2003.

3. Digital Integrated Circuits - John M. Rabaey, PHI, EEE, 1997.

4. Modern VLSI Design - Wayne Wolf, Pearson Education, 3rd Edition, 1997.

Name of The Course	Biotransport Process			
Course Code	BMET 6007			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Biotransport Process

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Basic concepts of transport processes
CO2	Understand the Heat transfer systems
CO3	Understand the Mass transfer principles
CO4	Understand the Mass transfer in artificial kidney devices
CO5	Understand about the Compartmental models
CO6	Analyze the Modeling of the body as compartment

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

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Course Contents

Unit-1: Basic concepts of transport processes	7 hours
Basic concepts of transport processes. Relationship between flow and effort variables. Chemical balances, force balances, general flow balances, Kirchhoff's laws, Conservation of mass, conservation of energy, momentum balance	
Unit-2: Heat transfer systems	7 hours
Heat transfer systems. Modes of heat transfer, conduction, convection and radiation. Heat production, heat loss to the environment, role of blood circulation in internal heat transfer, models for heat transfer within the body.	
Unit-3: Mass transfer principles	7 hours
Mass transfer principles. Mass balance, molecular diffusion, Transport through cell membranes. Mass transfer in kidneys, models of nephron function, gas transport mechanisms in the lungs and blood. Modelling of oxygen and inert gas uptake in the lungs.	
Unit-4: Mass transfer in artificial kidney devices	7 hours
Mass transfer in artificial kidney devices, modeling of patient-artificial kidney system. Comparison of natural and artificial lungs. Models for blood oxygenation, analysis of gas transport in membrane oxygenators.	
Unit-5: Compartmental models	7 hours
Compartmental models. Approaches to pharmacokinetic modeling and drug delivery, one and two compartmental models. Physiological applications-intravenous injection, constant intravenous infusion, determination of regional blood flow volumes and blood flow rates.	
Unit-6: Modeling of the body as compartment	5 hours
Modeling of the body as compartment; Source and stream; heat exchange between human body and its environment; mass transfer in membrane; heamodialysis as related to artificial kidney; Oxygen Transport in Biological Systems, extracorporeal devices, Pharmacokinetic Analysis.	

Suggested Readings:

1. "Biomedical Engineering Principles, An Introduction to fluid , heat and mass transfer process", Cooney D. O., Marcel Dekker Inc, (1976).

2. "Transport Phenomena is living systems- Biomedical Aspects of Momentum and Man Transport", Lightfoot E. N., John Wiley (1974).

3 "Basic transport phenomena in biomedical engineering", Fournier, Ronald L., Taylor & Francis, 1998.

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Semester VII

Name of The Course	BioMEMS and Biosensors				
Course Code	BMET 7001				
Prerequisite					
Corequisite					
Antirequisite					
	L	T	P	C	
	3	0	0	3	

Course Objectives:

Students will understand about the BioMEMS and Biosensors

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Introduction to BioMEMS
CO2	Understand the Soft fabrication and polymers
CO3	Understand the MEMS biosensors
CO4	Understand the Microarrays
CO5	Understand about the Biological sensors
CO6	Analyze the Applications of biosensors

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Introduction to BioMEMS	7 hours
Introduction to bio-MEMS. Materials for bio-MEMS. BioMEMS fabrication: bulk/surface micromachining, LIGA.	
Unit-2: Soft fabrication and polymers	7 hours
Soft fabrication and polymers (soft-lithography, micromolding, micro- stereolithography, thick-film deposition, SAMs. Microfluidic principles. Microfluidic devices: microchannels, microvalves, micropumps, micro- needles, microreserviors, micro-reactors;	
Unit-3: MEMS biosensors	7 hours
MEMS biosensors. Microactuators and micro drug delivery system. Micro total analysis system (μTAS), lab-on-a-chip.	
Unit-4: Microarrays	7 hours

Microarrays: polymerase chain reactor (PCR), DNA chip, functional genomics, bioinformatics. BioMEMS for tissue engineering. Packaging, power, data and RF safety of bioMEMS	
Unit-5: Biological sensors	7 hours
Chemoreceptors, Baroreceptors, Touch receptors; Biosensors; Working Principle and Types, - molecular recognition elements, transducing elements.	
Unit-6: Applications of biosensors	5 hours
Enzyme-based biosensors, e.g., the blood glucose sensor; Array-based DNA "biochip" sensors with fluorescence detection; Applications of molecular recognition elements in nanosensing of different analytes; Application of various transducing elements as part of nanobiosensors	

Suggested Readings:

1. Mauro Ferrari (editor), BioMEMS and Biomedical Nanotechnology: I: Prospectus, Biological and Biomedical Nanotechnology (A. Lee, L. Lee); II: Micro and Nano-Technologies for Genomics and Proteomics (M. Ozkan and M. Heller); III: Therapeutic Micro/Nanotechnology (T. Desai and S. Bhatia); IV: Biomolecular Sensing, Processing and Analysis (R. Bashid and S. Wereley), Springer, 1st edition, Nov. 30, 2006, ISBN: 0387255613
2. Gerald Urban, BioMEMS (Microsystems), Springer, 1st edition, May 5, 2006, ISBN: 0387287310.
3. Wanjun Wang, Steven A. Soper, Bio-MEMS: Technologies and Applications, CRC Press, 1st edition, Dec. 15, 2006, ISBN: 0849335329.
4. Ville Kaajakari, Practical MEMS: Design of microsystems, accelerometers, gyroscopes, RF MEMS, optical MEMS, and microfluidic systems, Small Gear Publishing, Mar. 17, 2009, ISBN: 0982299109.
5. Marc J. Madou, From MEMS to Bio-MEMS and Bio-NEMS: Manufacturing Techniques and Applications, CRC Press, 1st edition, Jun. 16, 2010, ISBN: 142005516X. Ellis Meng, Biomedical Microsystems, CRC Press, 1st edition, ISBN: 1420051229, Sept. 17, 2010.

Name of The Course	Artificial Intelligence & Pattern Recognition			
Course Code	BMET 7002			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Artificial Intelligence & Pattern Recognition in biomedical engineering applications

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Introduction to Artificial Intelligence
CO2	Understand the Knowledge representation
CO3	Understand the Pattern Recognition Concepts
CO4	Understand the Linear discriminant functions
CO5	Understand about the Supervised learning and clustering
CO6	Analyze the

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Introduction to Artificial Intelligence	7 hours
Definition of Artificial Intelligence, History and Applications, Components of AI Structures and Strategies for state space search- Data driven and goal driven search , Depth First and Breadth First Search, DFS with Iterative Deepening ,Heuristic Search- Best First Search, A* Algorithm, Constraint Satisfaction.	
Unit-2: Knowledge representation	7 hours
Knowledge representation - Propositional calculus, Predicate Calculus, Theorem proving by Resolution, Answer Extraction, AI Representational Schemes- Semantic Nets, Conceptual Dependency, Scripts, Frames	
Unit-3: Pattern Recognition Concepts	7 hours
Introduction to statistical, syntactic and descriptive approaches, features and feature extraction, learning; Bayes Decision theory- introduction, continuous case, 2-categoryclassification, minimum error rate classification, classifiers, discriminant functions, and decision surfaces. Error probabilities and integrals, normal density, discriminant functions for normal density, Bayes Decision theory Discrete case	
Unit-4: Linear discriminant functions	7 hours
Linear discriminant functions- linear discriminant functions and decision surfaces, generalized linear discriminant functions, 2-category linearly separable case, non-separable behavior, linear programming procedures	
Unit-5: Supervised learning and clustering	7 hours
Supervised learning and clustering- Mixture densities and identifiably, Maximum likelihood estimates, application to normal mixtures, unsupervised Bayesian learning, data description and clustering, Hierarchical clustering, low dimensional representation of multidimensional map	
Unit-6: Applications of deep learnin	5 hours
Applications of deep learning to electronic health records and medical imaging data; Applications of deep learning to predicting protein structure and pharmacogenomics	

Suggested Readings:

1. Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall Press, Upper Saddle River, NJ, USA.
2. Toby Segaran. 2007. Programming Collective Intelligence (First ed.). O'Reilly.
3. Tony J. Cleophas and Aeilko H. Zwinderman. 2015. Machine Learning in Medicine - a Complete Overview. Springer

4. Sunila Gollapudi, S. 2016. Practical Machine Learning. Packt Publishing Ltd.
5. Peter Harrington. 2012. Machine Learning in Action. Manning Publications Co., Greenwich, CT, USA.

Name of The Course	Modeling of Physiological System			
Course Code	BMET 7003			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the Modeling of Physiological System

Course Outcomes:

After completion of this course work students able to

CO1	Understand the Basic Concepts of Physiological System
CO2	Understand the Equivalent circuit model
CO3	Understand the Linear Model
CO4	Understand the Modelling of Blood flow and Urine formation
CO5	Understand about the Cardio-Pulmonary Modelling
CO6	Analyze the Eye Movement Model

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Contents

Unit-1: Basic Concepts of Physiological System	7 hours
Basic Concepts of Physiological System: Introduction to physiological system and mathematical modelling of physiological system The technique of mathematical modeling, classification of models-black box & building block, characteristics of models. Purpose of physiological modeling and signal analysis, linearization of nonlinear models. Engineering system and physiological system, System variables & properties- Resistance, Compliance & their analogy. Time invariant and time varying systems for physiological modeling.	
Unit-2: Equivalent circuit model	7 hours
Equivalent circuit model: Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley's	

model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron	
Unit-3: Linear Model	7 hours
Linear Model: Respiratory mechanics & muscle mechanics, Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & frequency analysis.	
Unit-4: Modelling of Blood flow and Urine formation	7 hours
Modelling of Blood flow and Urine formation: Electrical analog of blood vessels, model of systematic blood flow, model of coronary circulation, transfer of solutes between physiological compartments by fluid flow, counter current model of urine formation, model of Henle's loop	
Unit-5: Cardio-Pulmonary Modelling	7 hours
Cardio-Pulmonary Modelling: Cardiovascular system and pulmonary mechanics modelling and simulation, Model of Cardiovascular Variability, Model of Circadian Rhythms	
Unit-6: Eye Movement Model	5 hours
Eye Movement Model: Types of Eye movement, Eye movement system and Wetheimer's saccade eye model. Robinson's Model, Oculomotor muscle model, Linear Reciprocal Innervations Oculomotor Model	

Suggested Readings:

1. Endarle, Blanchard & Bronzino, Introduction to Biomedical Engg. , Academic press.

2. Suresh.R.Devasahayam, Signals & Systems in Biomedical Engineering, Kluwer Academic/ Plenum Publishers.

3. V.Z. Marmarelis, Advanced methods of physiological modeling, Plenum Press.

4. J. Candy, Signal Processing: The Model Based approach, Mc. Graw Hill.

5. L.Stark, Neurological Control System, Plenum Press.

6. R.B. Stein, Nerve and Muscle, Plenum Press.

Name of The Course	Hospital and Healthcare Administration				
Course Code	BMET 7004				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives:
The students will be familiarized with to know about Indian healthcare system: The Indian healthcare sector is expanding rapidly, with an estimated market value of US$ 280 billion by 2020.

This course will provide strategic insights and business skills for those working across the worldwide health sector.

Course Outcomes

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

CO1	Basic concepts of Health, Natural history of disease and role of hospitals to offer various levels of care
CO2	Introduction to Hospital Management, Concepts of Healthcare industry, Department and organization structure of different types of hospitals
CO3	Hospital's Department, Supportive and Ancillary service Departments
CO4	Basics of Drug Management, Computerized Drug management system
CO5	Procurement of Drugs, Procedure of drug indenting
CO6	Analyze the Health Systems in India

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Content

Unit-1: Basic Concepts of Health	7 hours
Concept of health & disease and well-being, Prevention aspect of diseases, Dynamics of disease transmission, Changing pattern of diseases, Common pathological conditions, Basic concepts of interpretation of investigations reports	
Unit-2: Introduction to Hospital Management	7 hours
Concepts of Healthcare industry and its ever-changing character, terminal planning, design and operation, Concept of hospitals, space required for separate functions, overview, design & planning of different types of hospitals, Problems and constraints in hospitals.	
Unit-3: Deparmentation in Hospital	6 hours
Organization, Structure, Vertical and Horizontal, Clinical and Non- Clinical, Supportive and Ancillary service Departments, Department and organization structure of different types of hospitals.	
Unit-4 : Basics of Drug Management	7 hours
Drug Management, Hospital Pharmacy License and Drug License, Narcotics drug storage, Pharmacy billings, Computerized Drug management system, Rational use of Drugs and Prescription Audits, Spurious Drugs, Banned Drugs	
Unit-5: Procurement of Drugs	6 hours
Purchase of drugs and other consumable materials, Procedure of drug indenting, On time drug dispensing inventory control, Methods of ordering – two bin system (lead time, buffer stock, reorder level) cyclic system	
Unit-6 Health Systems in India	7 hours
Health planning in India including various committees and National Health Policy and Health Goals set from time to time. Organised sector with reference to Centre, State, District and Block level structures and local bodies and Panchayati Raj Organisation and functions of community health centres and Primary Health Centres (PHCs). Health Manpower, Primary Health care and concept, Alternative systems of medicine, like Ayurveda, Homeopathy, etc. Holistic Approach Non-Governmental Organisations (NGOs) and Private Voluntary Organisations (PVOs). Unorganized Sector	

Suggested Readings:

1. Hospital Management: Principle, Theory and Practice by Amit Virmani
2. Hospital Management: An Evaluation – by A.K. Malhotra
3. Principles of Hospital Administration & Planning: B.M. Sakharkar (Jaypee)

Name of The Course	Fundamentals of Clinical Research			
Course Code	BMET 7005			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	T	P	C
	3	0	0	3

Course Objectives

1. Students will be exposed to Clinical Research and their requirements, Pharmaceutical Industry, Bioavailability and Bioequivalence Studies.

Course Outcomes

CO1	Historical Aspects of clinical research, clinical research terminologies
CO2	Phases of Clinical Trial and Types of Clinical Trial including Virtual Clinical Trials
CO3	Pharmaceutical Industry and concepts of Intellectual Property Rights
CO4	Modules of International Conference on Hormonization (Quality, Safety, Efficacy and Miscellaneous) and E6 Overview
CO5	Drug Regulation and Evidence based medicine
CO6	Analysis of Evidence-based medicine

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Basic Introduction to Clinical Research 7 Hours
Overview, Opportunities & Career options in Clinical Research, Glossary of GCP. Historical Aspects of clinical research, Brief description of different phases, Stakeholders in clinical research, Need/Area for clinical research.
Unit-2 Phases and Types of Clinical Trials 7 Hours

Introduction to Clinical Trials – Phases of Clinical Trials, Types of Clinical Trials, Randomized/Non randomized Clinical Trial, Virtual-clinical trials, Drug discovery and development.
Unit-3 Pharmaceutical Industry & globalization 7 Hours
Overview of global and local players, Intellectual Property Rights: Introduction, Scope, Objectives and concepts of IPR, Tangible & Intangible property, scope & nature of patents, copyrights, trademark, Indian Patent Act 1970, practical aspects of patent filing.
Unit-4: ICH Introduction 7 Hours
ICH Introduction, Origin, Organization, Structure, Modules of ICH (Quality, Safety, Efficacy and Miscellaneous), E6 Overview
Unit-5: Introduction to Indian GCP and ICMR 5 Hours
Indian- good clinical practice, Overview of ICMR
Unit-6: Evidence-based medicine
Need for evidence based approach in making decisions in family medicine; difference between evidence based medicine and evidence based health care; classification of evidence – information levels; 5 steps process for use of evidence oriented approach in family medicine

Suggested Reading

1. Indian GCP Guideline.
2. NDCT 2019
3. Design and Analysis of Clinical Trials: Concepts and Methodologies, 3rd Edition. SheinChung Chow, Jen-Pei Liu. Publisher: Wiley.
4. Principles and Practice of Pharmaceutical Medicine, 3rd Edition. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier. Publisher: Wiley-Blackwell
5. Methodology of Clinical Drug Trials, 2nd Edition. Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger

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Elective-V

Name of The Course	Introduction to Bioinformatics			
Course Code	BMET 7006			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives: Students are able to understand the basic concept of bioinformatics.

Course Outcomes

CO1	Describe the Introduction of Computer Fundamentals
CO2	It Interpret the Introduction of Bioinformatics and Biological Databases
CO3	Demonstrate Sequence Alignments, Phylogeny and Phylogenetic trees
CO4	Evaluate Genome organization and analysis
CO5	EvaluateProtein Structure Predictions
CO6	Analyze the Biomolecular Simulations

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Content:

Unit-1 Introduction To Computer Fundamentals 7 hours
RDBMS - Definition of relational database, Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer.
Unit-2 Introduction To Bioinformatics And Biological Databases 7 hours
Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.
Unit-3 Sequence Alignments, Phylogeny And Phylogenetic Trees 7 hours
Local and Global Sequence alignment, pairwise and multiple sequence alignment. Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices. Types of phylogenetic trees, Different approaches of phylogenetic tree construction -UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood.
Unit-4 Genome Organization And Analysis 7 hours
Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes; Genome, transcriptome, proteome, 2-D gel electrophoresis, Maldi Toff spectroscopy; Major features of completed genomes: *E.coli*, *S.cerevisiae*, *Arabidopsis*, and Human.

Unit-5 Protein Structure Predictions 7 hours	
Hierarchy of protein structure - primary, secondary and tertiary structures, modelling; Structural Classes, Motifs, Folds and Domains; Protein structure prediction in presence and absence of structure template; Energy minimizations and evaluation by Ramachandran plot Protein structure and rational drug design.	
Unit-6 Biomolecular Simulations 5 hours	
Force field and energy landscape; Minimization and alogrithms; Molecular dynamics; Free energy calculations; Membrane simulations	

Suggested Readings:

1. Saxena Sanjay (2003) A First Course in Computers, Vikas Publishing House
2. Pradeep and Sinha Preeti (2007) Foundations of Computing, 4th ed., BPB Publications
3. Lesk M.A.(2008) Introduction to Bioinformatics . Oxford Publication, 3rd International Student Edition
4. Rastogi S.C., Mendiratta N. and Rastogi P. (2007) Bioinformatics: methods and applications, genomics, proteomics and drug discovery, 2nd ed. Prentice Hall India Publication
5. Primrose and Twyman (2003) Principles of Genome Analysis & Genomics. Blackwell

Name of The Course	Molecular Diagnostics & Therapeutics			
Course Code	BMET 7007			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

Students will understand about the tools and techniques used in the molecular diagnosis & Therapeutics.

Course Outcomes:

After completion of this course work students able to

CO1	Understand the basic concepts of host pathogen interactions and Biomarkers
CO2	Understand the biochemical based diagnosis.
CO3	Understand the DNA based diagnosis
CO4	Understand the protein based diagnosis
CO5	Understand the Cellular therapy
CO6	Understand about the Recombinant therapy & Immunotherapy

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Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Course Content:

Unit-1: Host pathogen interactions and Biomarkers	7 hours
Biomarkers- types and applications; Host pathogen interactions in disease process; Protective immune response in Bacterial, Viral and Parasitic diseases; Cancer; Inappropriate Immune response; Disease pathology and clinical spectrum; Clinical diagnosis of diseases; Molecular Genetics of the host and the pathogen	
Unit-2: Biochemical based diagnosis	7 hours
Biochemical disorders; Molecular techniques for analysis of these disorders; Assays for the Diagnosis of inherited diseases; Antibody based diagnosis; Monoclonal antibodies as diagnostic reagents; Production of monoclonal antibodies with potential for diagnosis; Diagnosis of bacterial, viral and parasitic diseases by using; ELISA and Western blot.	
Unit-3: DNA based diagnosis	7 hours
Aptamers; DNA sequencing and diagnosis; PCR and Array based techniques in diagnosis; Single nucleotide polymorphism and disease association; Two dimensional gene scanning.	
Unit-4: Protein based diagnosis	5 hours
Protein Micro array; Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS; Ethics in Molecular Diagnosis	
Unit-5: Cellular therapy	7 hours
Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells; Clinical applications; Ethical issues	
Unit-6: Recombinant therapy & Immunotherapy	7 hours
Recombinant therapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors; Immunotherapy; Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosupressors in organ transplants; Role of cytokine therapy in cancers; Vaccines: types, recombinant vaccines and clinical applications	

Suggested Readings:

1. Campbell, M.A and Heyer L.J., Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, CSHL Press, Pearson/Benzamin Cummings San Francisco, USA, 2007.
2. Andrew Read and Dian Donnai, New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007.
3. James W Goding, Monoclonal antibodies: Principles and Practice, 3rd Edition, Academic Press, 1996.
4. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
5. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1 st Edition, Academic Press, 2005.
6. Lela Buchingham and Maribeth L Flawsm, Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1 st Edition, F A Davis Company, Philadelphia, USA, 2007.

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Name of The Course	Major Project				
Course Code	BMEP 8051				
Prerequisite					
Corequisite					
Antirequisite					
	L	T	P	C	
	0	0	24	12	

Course Objectives:
Students will get exposure of Project work execution in the area of Biomedical Engineering.

Course Outcomes

On completion of this course the students will be able to

CO1	Formulate questions and to discover feasible solutions
CO2	Demonstrate individual initiative or group responsibility
CO3	Use resource materials to express ideas and talents
CO4	Design and execute the project work
CO5	Report the project work in terms of thesis

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
60	00	240	300

Course Content

Unit-1: Biomedical Engineering Major Project
Six components are required for project completion: 1.Self-Management component 2. Written component 3. Research component 4. Oral component 5. Technological component 6. Visual component This project work is to make the student acquainted with the Patient/Healthcare sector/ industrial/Medical Diagnosis and Therapeutics. After completion of the project they will have to submit dissertation report This project work or thesis presents a student's research results, describing the research with reference to relevant work done as part of the live project at a Hospital/Healthcare sector/Biomedical Companies with specific diseases, diagnosis and therapeutic or rehabilitation engineering. It will include a description of the methods of research considered, and those actually employed, and present the student's conclusions. The thesis is the student's own work and must be written by the student. The Internal Layout of the project work or Thesis

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The thesis is to be submitted in the following pattern,

- Title page;
- Declarations and Statements
- Author's declaration
- Acknowledgement
- Contents page;
- Table of contents
- List of tables
- List of figures
- Definitions or Abbreviations
- Summary (Abstract)
- Introduction
- Literature Review
- Materials and Methods
- Results & Discussion
- Conclusion and Future Prospectives
- List of references
- Index