INTEGRAL UNIVERSITY, LUCKNOW

SYLLABUS

&

EVALUATION SCHEME

for

M.Tech BIOMEDICAL ENGINEERING (EVENING)

1st Year

(with effect from 2021-22)

INTEGRAL UNIVERSITY
DEPARTMENT OF BIOENGINEERING

PROGRAMME: M. Tech Biomedical Engineering

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO1: Apply advanced concepts of Biomedical Engineering to design and develop components and systems for health care applications

PSO2: Use state-of-art hardware and software tools to design experiments in medical electronic systems for the benefit of society.

PSO3: To exhibit independent, and collaborative research with strategic planning, while demonstrating the professional and ethical responsibilities of the engineering profession

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PE01 An ability to analyze and solve industry's technological problems

PE02 An ability to take active role in the management of Biomedical sectors

PE03 An ability to engage in ethical practice and lifelong learning so as to adapt to future professional challenges

PROGRAM OUTCOMES (PO):

PO1- Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2- Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3- Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4- Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5- Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6- The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7- Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9- Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10- Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11- Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12- 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.

M. Tech BIOMEDICAL ENGINEERING (Evening)

(w.e.f. session 2021-2022)

1st Year **1st Semester**

S. No.	Course Category	Subject Code	Subject	Credits				Evaluation Scheme				Subject Total
								Sessional (CA)			(ESE)	
				L	T	P	C	CT	TA	Total		
1	DC	BEE583	Anatomy & Physiology	3	1	0	4	40	20	60	40	100
2	DC	BEE584	Basic Electronics & Measurements	3	1	0	4	40	20	60	40	100
3	DC	BEE585	Biomedical Sensors & Data Acquisition Techniques	3	1	0	4	40	20	60	40	100
Total				09	03	00	12	120	60	180	120	300

ANATOMY AND PHYSIOLOGY

BEE583

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. To define the basic concepts of anatomical and physiological terminologies relating to cell, blood components and joints with their functions.
2. To describe the chemical coordination of human endocrine systems, hormones and its functions, male and female reproductive organs.
3. To brush the basics of anatomical and physiological functions of cardiovascular system, blood pressure with factors affecting it, Human Respiratory system, and mechanism of breathing and gaseous exchange.
4. To discuss about the human Nervous system, physiology and terminologies involved in it, Functions of brain, vision, hearing, taste and smell, Urinary System, functions of kidney and urine formation Functions and absorption property of digestive system and its movement.
5. Ability to understand the necessary information about the human body mechanism with its physiological functions

UNIT I	**Basics of Anatomy and Physiology:** Introduction to Human anatomy and physiology- Anatomical and medical terminology- Structure of the human cell – Four primary tissues, organs and organ systems – Physiology of homeostasis. Osteology and joints- Muscles. Body fluids- Composition and functions of blood- Plasma proteins- Red blood cells, White blood cells and platelets- Blood groups and blood clotting.	**8**
UNIT II	**Cardiovascular and Respiratory System:** Structure of the heart and blood vessels, Conducting system of the heart and electrocardiogram, Arterial blood pressure – Factors maintaining blood pressure, Factors regulating blood pressure. Organs of respiratory system – Structure of lungs, Mechanics of breathing, Lung volume and capacities- Transport of Oxygen in the blood, Transport of carbon-di-oxide in the blood Regulation of respiration- Hypoxia, Dyspnea.	**8**
UNIT III	**Nervous System and Special Senses:** Structure of neuron- Resting membrane potential and action potential, Neuromuscular junction, Synaptic transmission, Brain and spinal cord, Reflex arc and reflex action, Functions of the parts of the brain – Vision, hearing, taste and smell.	**8**

UNIT IV	**Urinary System and Digestive System:** Structures of urinary system (Malpighian corpuscles, Proximal convoluted tubule, loop of Henle and Distal convoluted tubule), Functions of the kidney, Innervations of urinary bladder. Organs of digestive systems - Salivary secretion, gastric secretion and pancreatic secretion, Bile secretion and functions of liver. Absorption of food substances. Movements of digestive tract.	**8**
UNIT V	**Endocrine and Reproductive Systems**: Concept of hormone – Types of hormones and hormone receptors – Adenohypophysis and neurohypophysis, Thyroid gland, Para thyroid gland, Islets of Langerhans, Adrenal modules and adrenal cortex – Male reproductive organs and functions of androgens, Female reproductive organs, functions of estrogen and progesterone.	**8**

Books Recommended:

1. Anne Waugh, Allison Grant, "Ross and Wilson Anatomy and Physiology in Health and Illness", 2014, 12th Edition, Churchill Livingstone, London.

Reference materials:

1. Richard S. Snell, "Clinical Anatomy by Regions", 2011, 8th edition, Lippincott Williams & Wilkins, Philadelphia.
2. Gerard J. Tortora, Bryan H. Derrickson, "Principles of Anatomy and Physiology", 2014,14th Edition, Wiley, New Jersey.

BASIC ELECTRONICS AND MEASUREMENTS

BEE584

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. To describe the basic concepts of electrical circuits and to demonstrate the analysis of DC and AC circuits using node and mesh analysis method; To acquaint the students with different types of diodes, transistors and op-Amps.

2. To elucidate the concepts of logic Circuits, memory types and illustrate the architecture and interfacing of 8051 microcontroller.

3. To teach the students to classify and perform several operations of signals; represent the signals and introduce the properties of Continuous and discrete time Fourier transform.

4. To acquaint the students with the different types of sensors and transducers, and their characteristics.

5. Analyze electric circuits using the circuit laws and to comprehend the I-V characteristics of diodes.

UNIT I	**Semiconductor Devices and Circuits:** PN Junctions- Formation of Junction- Physical operation of diode, Contact potential and Space Charge phenomena, I - V Characteristics, Zener diode- Introduction to BJT, FET, MOSFET, amplifiers based on BJT and FET - Ohm's Law - KCL, KVL, Node Voltage Analysis, Mesh Current.	**8**
UNIT II	**Integrated Circuits:** Op-Amp Fundamentals, Practical Limitations of op-amps, Frequency compensation and stability, Gain bandwidth product, Voltage Follower, Introduction to Instrumentation amplifier.	**8**
UNIT III	**Digital Systems:** Basic Logic Circuit Concepts- Representation of Numerical Data in Binary Form - Combinatorial and Sequential Logic Circuits - Synthesis of Logic Circuits - Computer Organization – Memory Types.	**8**
UNIT IV	**Signals and Systems:** Continuous-time and Discrete-time Signals: Representation of signals, Signal classification, Types of signals - Operations on signals - Scaling, Shifting, Transformation of independent variables. Sampling LTI Systems - Continuous-Time and Discrete-Time Fourier transforms - Properties.	**8**

UNIT V	**Biopotential Measurement:** Transducers - Electric Transducers – Classification based upon principle of transduction, Characteristics and choice of Transducers, Classification and basic requirements of bio transducers, Factors influencing the choice of the transducer in measuring the Physiological Parameters- Electrodes for ECG, EEG, EMG, EOG.	**8**

Books Recommended:

1. Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, "Microelectronic Theory and Applications", 2013, 6th edition, Oxford University Press, New Delhi
2. E.W Golding, F.C Widdis, "Electrical Measurements and Measuring Instruments", 2011, 1st edition, Reem Publications Pvt. Ltd, New Delhi..

Reference materials:

1. Allan V. Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", 2015, 2nd edition, Pearson Education India, Bengaluru.
2. Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 2011, 1st edition, Wiley Eastern Ltd, Bengaluru.
3. William L Fletcher, "Engineering Approach to Digital Design", 2015, 1st edition, Pearson Education India, Bengaluru.
4. Muhammad Ali Mazidi, Janice Giillispie Mazidi, "8051 Microcontroller and Embedded Systems", 2014, 2nd edition, Pearson New International Edition, Essex.
5. Jacob Millman, Christos C Halkias and Satyabrata Jit, "Electronic devices and circuits", 2015, 2nd edition, Tata Mc Graw Hill, New Delhi.
6. John. G. Webster and Halit Eren, "Measurements, Instrumentation and Sensors Handbook: spatial, mechanical, thermal and radiation measurements", 2014, 2nd edition, CRC Press, Florida.

BIOMEDICAL SENSORS AND DATA ACQUISITION TECHNIQUES

BEE585

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. To relate the principles of bio potential sensing and electrodes to biomedical applications.
2. To identify the type of signal conditioning needed and the data acquisition cards for a specific sensor output.
3. To acquaint the students with the communication standards and PC buses for data acquisition.
4. To introduce virtual instrumentation and the hardware interfacing.
5. Design a prototype of a medical device

UNIT I	**Bioelectrodes:** Origin of bio potential and its propagation. Electrode-electrolyte interface, Electrode–skin interface, Half-cell potential, Impedance, Polarization effects of electrode – Non-polarizable electrodes. Types of electrodes - Surface, Needle and Micro electrodes and their equivalent circuits. Recording problems - Measurement with two electrodes.	**8**
UNIT II	**Physiological Transducers:** Thermoresistive – Thermoelectric – Semiconductor - Piezoelectric sensors- Electrets in Capacitive transducers- Pyroelectric effect – Piezoresistive effect- strain gauges- Hall Effect-Magnetostrictive effect, SQUID – AC/DC bridges - Temperature compensation.	**8**
UNIT III	**Fundamentals of Bioelectric Signal Acquisition:** Introduction to bioelectric signals- Configuration and structure- Interface systems- Review of quantization in amplitude and time axis.	**8**
UNIT IV	**Bioamplifiers:** Need for bio-amplifier - Single ended bio-amplifier, Differential bio-amplifier – Right leg driven ECG amplifier- Band-pass filtering,	**8**

	Isolation amplifiers – Transformer and optical isolation - Isolated DC amplifier and AC carrier amplifier. Chopper amplifier- Power line interference, Macroshock and Microshock, Preventive measures to reduce shock hazards.	
UNIT V	**DAQ cards:** Analog to digital conversion and Data acquisition cards- Analog and digital inputs, Counter timer I/O-accuracy and dynamic range, Speed vs throughput-Acquisition of general waveforms and biosignals- Issues in online monitoring- Web-based online monitoring.	**8**

Books Recommended:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", 2015, 2nd Edition, Pearson Education India, Bengaluru.
2. John G. Webster, "Medical Instrumentation Application and Design", 2015, 4th Edition, John Wiley and sons, New Jersey.

Reference materials:

7. Robert H King, "Introduction to Data Acquisition with LabVIEW", 2012, 2nd Edition, McGraw Hill, New York.
8. Joseph Bronzino and Donal R. Peterson, Handbook of Biomedical Engineering, 2015, 4th Edition, CRC Press, Florida.

M. Tech BIOMEDICAL ENGINEERING (Evening)

(w.e.f. session 2021-2022)

1st Year **2nd Semester**

S. No.	Course Category	Subject Code	Subject	Credits				Evaluation Scheme				Subject Total
								Sessional (CA)			(ESE)	
				L	T	P	C	CT	TA	Total		
1	DC	BEE586	Biomedical Equipments	3	1	0	4	40	20	60	40	100
2	DC	BEE587	Embedded Systems and IoT for Biomedical Applications	3	1	0	4	40	20	60	40	100
3	DC	BEE588	Biomedical Equipments Lab	0	0	4	2	40	20	60	40	100
Total				**06**	**2**	**4**	**10**	**120**	**60**	**180**	**120**	**300**

BIOMEDICAL EQUIPMENTS

BEE586

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. Discuss and express the basic principle, working and design of various bio potential recording equipment
2. To acquaint the students with the different types of flowmeters and radiation detectors and the analytical equipment used in medical field.
3. To describe the modes of operation and functioning of cardiac and respiratory devices.
4. To provide a comprehensive knowledge of the features of extracorporeal dialysis units, physiotherapy and surgical equipment.
5. Comprehend the working principle and applications of the analytical equipment used in medical field.

UNIT I	**Analytical & Diagnostic Instruments:** Common analytical equipment used in hospitals and those in Biochemistry laboratories - Blood Flow meters - Pulmonary function analyzers - Blood gas analyzers - Different types of Oximetry systems - Blood pressure measurement - Blood cell counters.	**8**
UNIT II	**Blood Flow Meters and Radiation Detectors:** Ultrasonic blood flow meters, NMR blood flow meter, Laser Doppler blood flow meters, Pulse oximeter- Radiation detectors, Pulse height analyzer, Gamma camera, Medical ultrasound, Basic pulse echo apparatus.	**8**
UNIT III	**Cardiac Devices:** External and Implantable Pacemaker, Performance aspects of Implantable Pacemaker - DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, Implantable defibrillator, defibrillator analyzers - Heart lung machine- Different types of Oxygenators, Pumps.	**8**
UNIT IV	**Hemodialysis Machine:** Basic principle of Hemodialysis and its type - Membrane, Dialysate, Different types of hemodialyzers, Monitoring Systems, Portable and	**8**

	Wearable Artificial Kidney, Implanting Type - Different types of dialyzer membrane	
UNIT V	**Ventilators and Anesthesia System:** Basic principles of ventilators, Different generators, Inspiratory phase and expiratory phase, Different ventilator adjuncts, Neonatal ventilators, Ventilator testing - Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Anaesthesia - Need of anaesthesia, Gas used and their sources, Gas blending and vaporizers, Anaesthesia delivery system, Breathing circuits.	**8**

Books Recommended:

1. Carr –Brown, "Introduction to Biomedical Equipment Technology", 2011, 1st Edition, Pearson, New York.

Reference materials:

1. John G. Webster, "Medical Instrumentation Application and Design", 2015, 4th Edition, John Wiley and sons, New Jersey
2. R S. Khandpur, "Handbook of Biomedical Instrumentation", 2014, 3rd Edition, Tata Mc Graw Hill, New Delhi..

EMBEDDED SYSTEM AND IoT FOR BIOMEDICAL APPLICATIONS

BEE587

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. Develop a comprehensive understanding of the technologies behind the embedded systems
2. Discover the programming concepts and embedded programming in linux
3. Discuss the overview of embedded networking
4. Introduce student to the Internet of things (IOT) with interfacing sensors, actuators for portable gadgets.
5. Understand the IoT application development.

UNIT I	**Introduction to Embedded Systems**	**8**
	Characteristics of embedded computing applications, concepts of real time systems, general purpose and customized processor, different architectures, caches, virtual memory. Embedded design life cycle – Tools used in Design Process – Challenges in Embedded system design for bio medical applications.	
UNIT II	**Health care System design using general purpose processor**	**8**
	ARM instruction set, ,ARM Cortex MX architecture, bus, exception, floating point implementation, memory map, bit banding, peripherals, Programming the peripherals, ADC,DAC, GPIO, Timer, PWM, UART, SPI, I2C, Embedded health care monitoring systems (Temperature, BP, Blood Glucose, non-invasive pulse oximeter, ECG & panic alarm).	
UNIT III	**IoT Architecture and platforms**	**8**
	History of IoT, M2M communication, Web of Things, IoT protocols, IOT reference layer, IoT Communication Pattern, IoT protocol Architecture, 6LoWPAN, Security aspects in IoT, Hardware platforms-ARM Cortex Processors, TI CC3200 Launch pad, Intel Galileo boards, fast prototyping using Proteus, Single board computers(SBC), Aurdino.	

UNIT IV	**Sensors with Cloud and Internet connectivity**	**8**
	Streaming sensor data to Internet, Control of IO ports on Sensor hardware from Internet, Headless systems programming and configuring, Working with MAC Addresses, Cloud Dashboards and Monitoring.	
UNIT V	**IoT in Biomedical Applications**	**8**
	IoT client and IoT gateway in healthcare, IoT driven smart health care application for everyday use, life critical applications, Health care IOT for rural area, Use of Big Data and Visualization in IoT, Industry4.0 concepts., sensor markup language.	

Books Recommended:

1. Samuel Greengard, "The Internet of Things", 2015, 1st Edition, MIT Press.

Reference materials:

1. Peter Waher, Learning Internet of Things, 2015, 1st Edition, Packt Publishing, Birmingham, United Kingdom
2. Arshdeep Bahga, Vijay Madisetti, "Internet of Things" (A Hands-on-Approach), 2014, 1st Edition, VPT publishing Inc.
3. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, 2013, 1st Edition, Wiley.

BIOMEDICAL EQUIPMENTS LAB

BEE588

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	0	0	4	2

Course Objectives:

1. To familiarize students with different types of medical equipments
2. To make them understand about the principle and working of versatile medical equipments
3. To familiarize students with the application of such equipments

Course Outcome:

After completion of the course the students will be able to

1. Describe different types of medical equipments
2. Explain the working principle of versatile medical equipments
3. Describe the application of such equipments

List of experiments:

1. Study on simulated DC defibrillator
2. Study on muscle stimulator
3. Study on ECG heart rate monitor with alarm system
4. Study on peripheral pulse rate monitor with alarm system
5. Study on digital body/skin temperature monitoring system
6. Study on US Doppler / Foetal monitor
7. Study on hearing aid and audiometer: air and bone conduction
8. Study on EMG bio-feedback system
9. Study on ECG simulator and servicing of ECG machine
10. Study on Baby incubator / Infusion pump

1.

M. Tech BIOMEDICAL ENGINEERING (Evening)

(w.e.f. session 2021-2022)

2nd Year **3rd Semester**

S. No.	Course Category	Subject Code	Subject	Credits				Evaluation Scheme				Subject Total
								Sessional (CA)			(ESE)	
				L	T	P	C	CT	TA	Total		
1	DC	BEE589	Bio-signal Processing and Analysis	3	1	0	4	40	20	60	40	100
2	DC	BEE590	Medical Image Processing	3	1	0	4	40	20	60	40	100
3	DC	BEE591	Medical Image Processing Lab	0	0	4	2	40	20	60	40	100
4	DC	BEE592	Bio-signal Processing Lab	0	0	4	2	40	20	60	40	100
Total				**6**	**2**	**8**	**12**	**160**	**80**	**240**	**160**	**400**

BIO-SIGNAL PROCESSING AND ANALYSIS

BEE589

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objective:

1. Compare the basic concepts of signals and analyse time and frequency based transforms.
2. To brush the basics of digital filters.
3. Students have to investigate the events in the signals.
4. Interpret the basic architecture of the DSP processor TMS 320 and its implementation, applications.
5. Acquaint the ECG processing and pattern recognition.

UNIT I	**Introduction to Biomedical Signal Analysis** Introduction to signals - Time domain - Statistical and information theoretic analysis	**8**
UNIT II	**Digital Filters** Types of artefacts and noise - Time domain filters, frequency domain filters, notch and comb filters, optimal filtering, adaptive filters - Signal decomposition based filtering.	**8**
UNIT III	**Event Detection and Feature Extraction Techniques** Signal segmentation - Envelop extraction and analysis, temporal, spectral, statistical, information theoretic and cross spectral features - Waveform complexity.	**8**
UNIT IV	**Time-Frequency Domain Analysis** Fourier spectrum of biosignals, short-time Fourier transform and spectrogram - DCT and its applications - Wavelet transform and time frequency analysis - Hilbert transform and its applications - Empirical mode decomposition and empirical wavelet transform - correlation analysis and power spectral estimation.	**8**
UNIT V	**Case Studies** Linear discrimination - detection of motor activity from EMG, Harmonic analysis - Estimation of heart rate in ECG - Auto-regressive model - Estimation of spectrum of thoughts in EEG -M matched and Wiener filter for filtering in ultrasound.	**8**

Books Recommended:

1. Rangaraj M. Rangayyan, “Biomedical Signal Analysis”, 2015, 2nd Edition, Wiley-IEEE Press, New York.

Reference materials:

1. Nasser Kehtarnavaz, "Real Time Signal Processing Based on TMS320C6000", 2011, 2nd Edition, Elsevier, Netherlands.
2. Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", 2012, 1st Edition, Wiley, New York.

MEDICAL IMAGE PROCESSING

BEE590

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objective:

1. To define the principles of image sampling, quantization, enhancement and filtering techniques
2. To discover the different image compression methods and morphological based processes and machine learning techniques for image segmentation
3. To develop the methods of image registration and visualization for medical applications.
4. To acquaint the student with the techniques of shape analysis and image classification using neural networks for brain computer interface and computer aided diagnosis.
5. Process the given medical images to enhance them.

UNIT I	**Image Fundamentals**	**8**
	Image perception- Image model- Image sampling and quantization - 2D DFT and DCT.	
UNIT II	**Image Enhancement and Filtering**	**8**
	Image enhancement- Histogram modelling, Spatial operations - Image restoration, Noise models, Image degradation model, Wiener filtering, Maximum entropy restoration	
UNIT III	**Image Compression and Morphological Processing**	**8**
	Image compression - Lossy and lossless Compression, Predictive techniques - Dilation, Erosion, Open, Close, Skeleton operations, Top-hat algorithm - Morphology based segmentation.	
UNIT IV	**Image Segmentation**	**8**
	Machine Learning based segmentation algorithms - Singular Value Decomposition (SVD) - Principal Component Analysis and its applications - Support Vector Machine and its applications - Independent Component Analysis and its application.	
UNIT V	**Image Registration and Visualization**	**8**
	Image Registration - Medical image Fusion, SPECT/CT, MR/CT, PET/CT - Image visualization - Volume Rendering, Surface rendering and Maximum Intensity Projection.	

Books Recommended:

1. Reiner Salzer, "Biomedical Imaging: Principles and Applications", 2012, 1st Edition, Wiley, New Jersey.

Reference materials:

1. Jonathan Wolpaw, Elizabeth Winter, (Eds.) "Brain-Computer Interfaces: Principles and Practice", 2012, 1st Edition, Oxford University Press, Oxford.
2. Pears, Nick, Liu, Yonghuai, Bunting, Peter (Eds.) "3D Imaging, Analysis and Applications", 2012, 2nd Edition, Springer, Berlin.

MEDICAL IMAGE PROCESSING LAB

BEE591

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	0	0	4	2

Course Objectives:

1. Comprehend image sampling and DFT
2. Apply compression techniques and morphological operations for segmentation
3. Predict a machine learning algorithm on the given image for segmentation

Course Outcome:

After completion of the course the students will be able to

1. Register images of different modalities, render their volumes for visualization
2. Use neural networks for image classification
3. Design and develop algorithms to process and visualize images from different modalities
4. Develop algorithms to process and visualize images from different modalities for diagnostic application

List of experiments:

1. Using spatial filters to enhance the given noisy image. Compare the performance of various filters
2. Design suitable filters in frequency domain for noise removal from the given image
3. Using region growing algorithm to segment the gray matter, white matter and CSF from the given MR brain image
4. Extract the features of interest from the given CT abdomen images and classify
5. Read and analyze the given PET and CT image and register them.

BIO-SIGNAL PROCESSING LAB

BEE592

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	0	0	4	2

Course Objectives:

1. Comprehend and analyse the signals in different statistical methods
2. To acquaint the transforms enactments on bio signal
3. Comprehend the implementations of filters in biosignals.

Course Outcome:

After completion of the course the students will be able to

1. EEG analysis and modelling
2. To familiarize the digital signal processor with its application aspects
3. Appreciate the operation of processors and its special applications

List of experiments:

1. Acquire noisy ECG signal. The sampling rate of the signal is 1,000 Hz. Develop a MATLAB program to perform synchronized averaging. Select a QRS complex from the signal for use as the template and use a suitable threshold on the cross-correlation function for beat detection. Plot the resulting averaged QRS complex and comment it. Observe the results when the threshold on the cross-correlation function is low (0.4) or high (0.95).

2. Record the EEG signals with spike-and-wave complexes. The sampling rate is 100 Hz per channel. Cut out one spike-and-wave complex from any EEG channel and use it as a template. Perform template matching by cross- correlation or by designing a matched filter. Apply the procedure to the same channel from which the template was selected as well as to other channels. Study the results and explain how they may be used to detect spike-and-wave complexes.

3. Acquire the ECG signal which contains a large number of PVCs, including episodes. Apply the Pan-Tompkins procedure to detect and segment each beat. Label each beat as normal or premature by visual inspection. Record the number of beats missed. Compute the RR interval and the form factor FF for each beat. Use a duration of 80 samples (400 ms) spanning the QRS - T portion of each beat to compute FF. The P wave need not be considered in the present exercise. Compute the mean and standard deviation of the FF and RR values for the normal beats and the PVCs. Evaluate the variation of the two parameters between the two categories of beats.

4. Compute the PSDs of a few channels of the EEG in the file eegl-xx.dat using Welch's procedure. Study the changes in the PSDs derived with variations in the window width, the number of segments averaged, and the type of the window used. Compare the results with the PSDs computed using the entire signal in each channel. Discuss the results in terms of the effects of the procedures and parameters on spectral resolution and leakage.

5. The file speech.wav contains the speech signal for the word "safety" uttered by a male speaker, sampled at 8 kHz. The signal has a significant amount of background noise. Develop procedures to segment the signal into voiced, unvoiced, and silence portions using ZCR measures. Compute the model based PSD for each segment. Compare the model PSD with the FFT-based PSD for each segment. What are the advantages and disadvantages of the model-based PSD in the case of voiced and unvoiced sounds?.

M. Tech BIOMEDICAL ENGINEERING (Evening)

(w.e.f. session 2021-2022)

2nd Year **4th Semester**

S. No.	Course Category	Subject Code	Subject	Credits				Evaluation Scheme				Subject Total
								Sessional (CA)			(ESE)	
				L	T	P	C	CT	TA	Total		
1	DC	BEE593	Rehabilitation Engineering	3	1	0	4	40	20	60	40	100
2	DE		Departmental Elective-I	3	1	0	4	40	20	60	40	100
3	DC	BEE594	Biomaterials	3	1	0	4	40	20	60	40	100
Total				**09**	**3**	**0**	**12**	**120**	**60**	**180**	**120**	**300**

DE : Big Data Analytics in Medical Applications (BEE595)

DE: Physiological Control Systems (BEE596)

REHABILITATION ENGINEERING

BEE593

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objective:

1. To identify the engineering concepts that can be applied in rehabilitation medicine and realize the role of engineers in various rehabilitation disciplines.
2. To predict the design of mobility aids like wheelchair, robotic legs and fabrication process of orthoses and prostheses.
3. To discover various tools available for sensory and motor rehabilitation
4. To identify the challenges faced in paediatric and geriatric rehabilitation and formulate the ways to overcome those challenges.
5. Understand the contemporary issues and methods that are faced and implement respectively during the rehabilitation process.

UNIT I	**Principle Of Rehabilitation Engineering** Introduction to Rehabilitation Engineering- Clinical practice of rehabilitation Engineering. Universal design - Design based on human ability - Standards for assistive technology. Mobility aids, Different kinds of wheelchair - Robotic legs - Myoelectric arm.	**8**
UNIT II	**Prosthetic And Orthotic Devices** Hand and arm replacement - Different types of models for externally powered limb prosthetics - Lower limb, Upper limb orthotics, and material for prosthetic and orthotic devices.	**8**
UNIT III	**Sensory Rehabilitation** Types of deafness - Hearing aids, application of DSP in hearing aids - Cochlear implants - Voice synthesizer, speech trainer - Ultra sonic, Infrared and LASER canes - Intra ocular lens - Braille Reader - Tactile devices for visually challenged - Text voice converter - Screen readers.	**8**
UNIT IV	**Motor Rehabilitation** Functional Electrical Stimulation - Robotics in rehabilitation - Sports, stroke and geriatric Rehabilitation - Assistive technology for	**8**

	dyslexia - Computer & internet access for challenged people - Neural engineering in rehabilitation engineering - Role of biomedical engineer in rehabilitation.	
UNIT V	**Geriatric and Pediatric Rehabilitation** Neurological - Visual and auditory challenges faced by geriatrics and methods to overcome those challenges. Neurological - Visual and auditory challenges faced by cerebral palsy - Muscular dystrophy and autism children - Methods to overcome those challenges.	**8**

Books Recommended:

1. MarionA Hersh, Michael A, Johnson, "Assistive Technology for Visually impaired and blind people", 2014, 1st Edition, Springer Verlag, London.

Reference materials:

1. Rory A, Cooper, Hisaichi Ohnabe, Douglas A, Hodson, "An Introduction to Rehabilitation Engineering", 2014, 1st edition, CRC Press, Florida.
2. Suzanne Robitaille, "The illustrated guide to Assistive technology and devices–Tools and gadgets for living independently", 2010, 2nd Edition, Demos Health, USA..

BIOMATERIALS

BEE594
(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objective:

1. To define the basic concepts of biomaterials, classification (metals, polymers, and ceramics, bioresorbable and biodegradable materials), different properties on materials used in medicine.
2. To describe the basics of in-vitro and in-vivo testing of biomaterials, materials degradation in body fluids and its effects.
3. To discuss the various process of wound healing and foreign body response, toxicity levels, blood material interactions and its associated infections.
4. To relate the biomaterial standards, Indian and international standards with its specifications.
5. Comprehend the basic biomaterials concepts with different classes, properties and standards to be used in healthcare industry.

UNIT I	**Introduction**	**8**
	History of biomaterials, General Properties of Bio–materials, Classes of materials used in medicine.	
UNIT II	**Properties of materials**	**8**
	Properties of materials - Bulk and surface properties and their characterization. Mechanical Properties of Biomaterials. Classes of materials used in medicine - Metals, Polymers, Hydrogels Bioresorbable and Biodegradable Materials	
UNIT III	**Metallic and Ceramic biomaterials**	**8**
	Stainless steel, Titanium, Alloys, Cardiovascular Orthopaedic and Dental applications. Corrosion of Bio-metals - Types of Valve Prostheses - Cardiac Stent- Bio-Ceramics - Bio–inert ceramics, Bio–active ceramics, Biodegradable ceramics, Alumina, Zirconia, Hydroxyapatite.	
UNIT IV	**Polymeric Biomaterials**	**8**
	Types of polymers - Sterilization, Structure, Bio-compatibility relationship, Stability, Examples of polymers used in medicine - Hydrogels and drug delivery systems - Sutures, Adhesives, and Hydro colloids - Super absorbents - artificial skin and blood.	
UNIT V	**Testing of biomaterials**	**8**
	In- vitro and In- vivo assessment of tissue compatibility - Testing of blood-materials interactions - Degradation of materials in the biological environment - Effects of the Biological environment on metals, polymers and ceramics.	

Books Recommended:

1. Michael F. Ashby, Hugh Shercliff, David Cebon, "Materials: engineering, science, processing and design", 2013, 3rd Edition, Elsevier Ltd, Cambridge.

Reference materials:

1. Ratner, Hoffman, Schoen, Lemons, "Biomaterials Science",2012, 1st Edition, Academic Press, Massachusetts.
2. Steven M. Kurtz , "PEEK Biomaterials Handbook",2011, 1st Edition, Elsevier, Atlanta.

BIG DATA ANALYTICS IN MEDICAL APPLICATIONS

BEE595

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objective: To introduce students to tools of data analysis used in biomedical engineering.

UNIT I	**Introduction to R**	**8**
	Introduction to R, variables and datatypes, data frames, operators in R, functions, control structures, data visualization in R	
UNIT II	**Linear algebra for data science**	**8**
	Algebraic view - vectors, matrices, product of matrix & vector, rank, null space, Geometric view - vectors, distance, projections, eigenvalue decomposition	
UNIT III	**Statistics**	**8**
	Sample statistics, Random variables, probability mass distribution, Hypothesis testing, Statistical modelling	
UNIT IV	**Optimization**	**8**
	Optimization for data science, Unconstrained and constrained multivariate optimization	
UNIT V	**Linear Regression**	**8**
	Univariate and multivariate linear regression Model assessment	

Recommended Books

1. Field, A., Miles, J., & Field, Z. (2012). *Discovering statistics using R*. Sage publications.
2. Crawley, M. J. (2012). *The R book*. John Wiley & Sons.
3. Caffo, B. (2015). Regression models for data science in R. *A companion book for the Coursera Regression Models class*.

PHYSIOLOGICAL CONTROL SYSTEMS
BEE596
(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. To introduce the basic system concepts and differences between an engineering and physiological control systems.
2. To acquaint students with different mathematical techniques applied in analyzing a system and the various types of nonlinear modelling approaches.
3. To teach neuronal membrane dynamics and to understand the procedures for testing, validation and interpretation of physiological models.
4. To study the cardiovascular model and apply the modelling methods to multi-input and multi output systems.
5. Develop simple models of the physiological control systems and analyze its stability.

UNIT I	**Introduction to Physiological Control Systems** Introduction-Systems Analysis: Fundamental concepts – Physiological control systems analysis: simple examples – Difference between engineering and physiological control systems.	**8**
UNIT II	**Mathematical Modeling** Generalized system properties – Models with combinations of systems elements – Linear models of physiological systems – Laplace transform and transfer functions.	**8**
UNIT III	**Time Domain Analysis of Linear Control Systems** Linearized Respiratory Mechanics: open loop vs closed loop - Open loop and closed loop Transient Response: First Order Model, Second Order Model - Descriptors of Impulse and Step Responses - Open loop versus closed loop Dynamics - A Model of Neuromuscular Reflex motion.	**8**
UNIT IV	**Frequency Domain Analysis of Linear Control Systems** Steady state responses to sinusoidal inputs - Graphical representation of frequency response - Frequency response of a model of circulatory control - Frequency response of Glucose Insulin regulation.	**8**
UNIT V	**Stability Analysis** Stability and Transient Response - Root Locus Plots - Routh -	**8**

	Hurwitz Stability Criterion – Nyquist Criterion for Stability - Relative Stability - Stability Analysis of the Pupillary light Reflex - Model of Cheyne-Stokes Breathing.	

Books Recommended:

1. Michael C.K. Khoo, Physiological Control Systems: Analysis, Simulation and Estimation, 2012, 1st Edition, Prentice Hall of India.
2. Joseph DiStefano, Dynamic Systems Biology Modeling and Simulation, 2015, 1st Edition, Academic Press, Massachusetts.

Reference materials:

1. H. Thomas Milhorn, Application of Control Theory to Physiological Systems, 2010, 1st Edition, Saunders (W.B.) Co Ltd., Philadelphia.
2. Robert Rushmer, Medical Engineering – Projections for Health Care Delivery, 2012, 1st Edition, Academic Press, Massachusetts.
3. David Cooney, Bio-Medical Engineering Principles, 2015, 1st Edition, Marcel Deckker Pub Co., New York.

M. Tech BIOMEDICAL ENGINEERING (Evening)

(w.e.f. session 2021-2022)

3rd Year **5th Semester**

S. No.	Course Category	Subject Code	Subject	Credits				Evaluation Scheme				Subject Total
								Sessional (CA)			(ESE)	
				L	T	P	C	CT	TA	Total		
1	DC	BEE676	Medical Imaging Techniques	3	1	0	4	40	20	60	40	100
2	DE		Departmental Elective-II	3	1	0	4	40	20	60	40	100
3	DC	BEE699	M.Tech. Dissertation	0	0	4	2	40	20	60	40	100
4	DC	BEE603	Colloquium	0	0	4	0	40	20	60	40	100
Total				**6**	**2**	**8**	**10**	**160**	**80**	**240**	**160**	**400**

DE: Digital Healthcare and Medical Standards (BEE677)

DE: Micro and Nano Fluidics (BEE678)

MEDICAL IMAGING TECHNIQUES

BEE676

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. To provide comprehensive understanding of medical image acquisition in different modalities and the historical evolution of these imaging methods.
2. To acquaint the students with different reconstruction techniques and noise removal for medical images and to apprise the manipulation of acoustic radiation fields for medical applications
3. To relate all the modules employed in magnetic resonance imaging and to demonstrate knowledge, clinical and technical skills and decision-making capabilities with respect to diagnostic imaging
4. To investigate the relevant theory to apply imaging principles for 3D visualization.
5. To compare the available processes, validate and interpret the medical images for a given application

UNIT I	**X-ray Projection Imaging** X-Ray tubes, cooling systems, removal of scatters, Fluoroscopy-construction of image – Intensifier tubes, Angiographic setup, Mammography, Scanning methods, Area detectors – Digital radiology, DSA - Electronic portal imaging - Noise, Artefacts.	**8**
UNIT II	**X ray Computed Tomography** Principles of sectional scanning - CT detectors, Helical CT, Multi-slice CT, Cone beam CT imaging methods - Methods of reconstruction-Iterative, Back projection, convolution and Back-Projection, FDK algorithm - Noise, Artefacts	**8**
UNIT III	**Radio Isotopic Imaging** SPECT- Radiation detectors, Radionuclides for imaging, Gamma ray camera, scanners, Positron Emission tomography – Iterative reconstruction algorithms, SPECT/CT,PET/CT registration	**8**
UNIT IV	**Ultrasonic Systems** Wave propagation and interaction in Biological tissues - Acoustic radiation fields, continuous and pulsed excitation - Transducers and imaging systems - Scanning methods, Imaging Modes, Principles and theory of image generation - lap top style units – Applications	**8**
UNIT V	**Magnetic Resonance Imaging** NMR - Principles of MRI, Relaxation processes and their measurements, Pulse sequencing and MRimage acquisition, Image reconstruction, Functional MRI, Diffusion imaging, EPI.	**8**

Books Recommended:

1. M A Flower, “Webb's Physics of Medical Imaging”, 2016, 2nd Edition, CRC Press, Florida.

Reference materials:

1. Jerry L. Prince and Jonathan M. Links, “Medical Imaging Signals and Systems”, 2014, 2nd Edition Pearson Education Inc., London
2. Paul Suetens, “Fundamentals of Medical Imaging”, 2017, 3rd Edition, Cambridge University Press, Cambridge.

DIGITAL HEALTHCARE AND MEDICAL STANDARDS

BEE677

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. To gain knowledge in various aspects of health informatics and medical standards.
2. To apply these techniques in proper health care delivery.
3. Understand the basic concepts in Biomedical Informatics.
4. Apply the various aspects of health informatics and medical standards.
5. Develop clinical decision support systems.

UNIT I	**Biomedical Informatics** Historical highlights and Evolution, Hospital Information System, its characteristics and functional online and offline modules, Health Informatics, Medical Informatics, Clinical Informatics, Nursing Informatics, Public Health Informatics, Imaging informatics.	**8**
UNIT II	**Electronic Patient Record and Standards** Electronic Patient Record, Medical data formats, Medical Standards, HL7, DICOM, LOINC, PACS, Medical Standards for Vocabulary, ICD 10, DRG, MeSH, UMLS, SNOMED. Healthcare Standards - JCAHO, HIPAA	**8**
UNIT III	**Electronic Decision Support Systems** Biomedical decision making. Probabilistic clinical reasoning. Medical Knowledge and Decision Support, Methods for decision support, Clinical decision-support systems, Strategies for medical knowledge acquisition, Predictive tools for clinical decision support.	**8**
UNIT IV	**Norms for Hospitals** Design and construction standards for the hospitals, BIS –India, JCIA, AIA and NHS, general guidelines and standard for out-patient area, in-patient area and diagnostic area in the hospitals.	**8**
UNIT V	**Standards for Hospitals** Voluntary & Mandatory standards, General standards, Mechanical standards, Electrical Standards, Standard for centralized medical gas system, Standards for biomedical waste.	**8**

Books Recommended:

1. Edward H. Shortliffe, James J. Cimino, "Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Health Informatics)", 2014, 4th edition, Springer, New York.

Reference materials:

1. Kenneth R. Ong, "Medical Informatics: An Executive primer", 2015, 1st edition, HIMSS Publishing, Chicago.
2. Lazakidou, Athina A., "Web-Based Applications in Healthcare and Biomedicine, Annals of Information Systems", 2010, 7th edition, Springer, New York.

MICRO AND NANO FLUIDICS

BEE678

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	3	1	0	4

Course Objectives:

1. Introduce and discuss the fundamental physics of micro and nano scale fluids and their hydrodynamics.
2. Comprehend techniques of miniaturization, methods and tools to create microfluidic architectures and discuss various existing microfluidic devices.
3. Discuss and identify the usage of microfluidics in various lab-on-chip and bioreactor applications
4. Investigate and compare microfabrication techniques to design vasculature and 3D microchannels.
5. Inception of historical background of evolution of MEMS and Microsystems to the students.

UNIT I	**Fundamentals for Microscale and Nanoscale Flow** Fluids and nonfluids, properties of fluids, classification of fluids, Newtonian and Non Newtonian fluids, pressure driven flow, reynolds number , Electrokinetic phenomena, Electric double layer, debye length, coupling species transport and fluid mechanics, Micro channel Resistance, Shear stress, capillary flow, flow through porous media, Diffusion, surface tension, contact angle and Wetting.	**8**
UNIT II	**Hydrodynamics** Introduction to surface, surface charge, surface energy, Thermodynamics of surfaces, Fluids in Electrical fields, The Navier Strokes equation, Boundary and Initial conditions problems.	**8**
UNIT III	**Fabrication methods and techniques** Patterning, Photolithography, Micromachining, Micromolding, Soft lithography, PDMS properties, Fabrication of microfludics channels.	**8**
UNIT IV	**Microfluidic Devices** Droplet Microfluids, Active Flow control, Microvalves, Electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers	**8**
UNIT V	**Microfluidics Lab on Chip** Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment.	**8**

Books Recommended:

1. Clement Kleinstreuer, "Microfluidics and Nanofluidics: Theory and Selected Applications", 2013, 1st ed., John Wiley & Sons, New Jersey.
2. Shaurya Prakash, Junghoon Yeom, "Nanofluidics and Microfluidics: Systems and Applications", 2014, 1st ed., William Andrew; Norwich, New York.

Reference materials:

1. Albert Folch, "Introduction to BioMEMS", 2012, 1st ed., CRC Press, United Kingdom. Patrick Tabeling, "Introduction to Microfluidics", 2011, Reprint ed., Oxford University Press, Great Britain.
2. Xiujun James Li, Yu Zhou , "Microfluidic Devices for Biomedical Applications", 2013, 1st ed., Wood head Publishing, Cambridge.
3. Terrence Conlisk. A, "Essentials of Micro- and Nanofluidics: With Applications to the Biological and Chemical Sciences", 2012, 1st ed., Cambridge University Press, New York.

M. Tech DISSERTATION

BEE699

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	0	0	4	2

Details:

1. **Design an IoT System for Vital Sign Monitors**

   a. Weight measuring device
   b. Blood pressure measuring device
   c. ECG
   d. Blood glucose measuring device
   e. Heart rates measuring devices
   f. Pulse Oximeters

2. **Design an IoT System for Activity Monitors**

   a. Walking time measuring device
   b. Step counting device
   c. Speed measuring device
   d. Calorie spent measuring device
   e. Time spent in rest or sleeping measuring device

3. **Using spatial filters enhance the given noisy image. Compare the performance of various filters 6 hours**
4. **Design suitable filters in frequency domain for noise removal from the given image 6 hours**
5. **Using region growing algorithm segment the gray matter, white matter and CSF from the given MR brain image 6 hours**
6. **Extract the features of interest from the given CT abdomen images and classify 6 hours**
7. **Read the given PET and CT image and register them**

COLLOQUIUM

BEE603

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	0	0	4	0

Objective: To acquaint the student with the various techniques used in contemporary research that will be useful in successful completion of their project work in the final year.

2. Searching for scientific literature (Science direct, SCOPUS, Google Scholar etc.)
3. Exposure to different manuscript forms (Review, Short note, Research article, Communication).
4. Design of experiments in research.
5. Basic statistical analysis (ANOVA, RSM, ANN).
6. Different manuscript formats and referencing styles (Use of Mendeley, Endnotes.).
7. Publishing manuscripts (plagiarism check, cover letters, suggesting reviewers etc).
8. Thesis writing and presentation.
9. Exposure of students to research in laboratory.
10. Ethics in conducting research.

M. Tech BIOMEDICAL ENGINEERING (Evening)
(w.e.f. session 2021-2022)

3rd Year **6th Semester**

S. No.	Course Category	Subject Code	Subject	Credits				Evaluation Scheme				Subject Total
								Sessional (CA)			(ESE)	
				L	T	P	C	CT	TA	Total		
1.	DC	BEE699	M.Tech. Dissertation	0	0	0	4	40	20	60	40	100
2.	DC	BEE699	M.Tech. Dissertation	0	0	0	4	40	20	60	40	100
3.	DC	BEE699	M.Tech. Dissertation	0	0	0	4	40	20	60	40	100
4.	DC	BEE699	M.Tech. Dissertation	0	0	0	4	40	20	60	40	100
Total				**0**	**0**	**0**	**16**	**160**	**80**	**240**	**160**	**400**

M. Tech DISSERTATION

BEE699

(w.e.f. session 2021-2022)

Pre-requisite	Co-requisite	L	T	P	C
None	None	0	0	0	4

Details:

To acquaint the student with the various techniques used in contemporary research in biomedical engineering that will be useful in successful completion of their project work in the fourth semester.

Guidelines:

1. The dissertation is concerned with a detailed and critical review of an area of interest. Typically, the report should contain and will be evaluated based on the following points:

    a. Introduction: 2 pages maximum,
    b. Exhaustive review of literature (including figures): 10 – 12 pages: 50% Weightage
    c. Critical analysis of the literature and comments on the analysis Critical analysis should also contain quantitative comparison of observations, results, and conclusion amongst the various papers.

2. Two typed copies of the report on thesis size A4 paper (297 mm x 210 mm) are to be submitted to Coordinator on **time to be decided by the coordinator.** The detailed timetable for the presentation would be communicated.
3. The report should be prepared using the Times Roman font (size 12) using 1 1/2 spacing leaving 1-inch margin on all sides producing approximately 29 lines per page. The report should be typed on one side of the paper and need not be bound in a hard cover binding. Figures and tables should be shown as a part of the running text. Each figure should be drawn inside a rectangular box of 12 cm width and 10 cm height. The figures must be sufficiently clear and hand drawn figures will be acceptable. Particular care must be taken if a figure is photocopied from source. Each figure must have a sequence number and caption below. Each table must have a sequence number and title at the top.
4. Name of the student, title of the problem and year of examination must be indicated on the top cover. THE NAME OF THE SUPERVISOR (ONLY INITIALS) MUST APPEAR ON THE BOTTOM RIGHT CORNER OF THE TOP COVER.
5. The report must be precise. All important aspects of the topic should be considered and reported. **The total number of pages, including tables, figures, and references should not exceed 30.** Chapters or subsections need not be started on new pages, while getting the report typed.

6. Typographical errors in the report must be corrected by the student. The student will be discredited for any omission in the report. All the symbols used in the text should be arranged in an alphabetical order and given separately after conclusions.
7. Referencing must be done using a reference manager tool (eg. EndNote, Mendeley, Zotero, etc.). The list of references should be arranged in alphabetical order of the names of authors. In the text, the reference should be cited with author's name and year. (author – date style) For example:
    i. The flow pattern in gas-liquid-solid fluidized bed has been reported in the published literature (Murooka et al., 1982).

    OR

    ii. Murooka et al. (1982) have measured flow patterns in gas-liquid-solid fluidized beds. The title of the article should also be included. The references must be given in the following standard format.

(a) Format for listing references of articles from periodicals: Murooka S., Uchida K. And Kato Y., Recirculation Turbulent Flow of Liquid in Gas-Liquid-Solid Fluidised Bed", J. Chem. Engg. Japan, 15, 29-34 (1982).

(b) Format for listing references of Books: Constant R.F.,"Crystallization, Academic Press, New York, pp. 89-90, 1968.

(c) Format for listing Thesis: Niranjan K., "Hydrodynamic and Mass Transfer Characteristics of Packed Columns", Ph.D. (Tech.) Thesis, University of Mumbai, 1983.

(d) Format for listing references of Patents in Chemical Abstracts: Cananaush R.M., U.S.Patent 2,647,141, Cf. C.A. 48, 82636 (1954).

(e) Format for listing Handbooks, Tables, Symposia etc.: Kumar R and Kuloor N.R., "Formation of Drops and Bubbles", in Advances in Chemical Engineering, Vol.8, T.B. Drew et.al. (Eds.) New York, Academic Press, pp.256-364 (1970).

(f) Format for listing Private Communications and other categories: Sharma, M.M., Private Communication (1984).

8. Consistency of units should be maintained in the written report. SI systems should be used. [For SI system – Ref: Ind. Chem. Engr., 24, 32, 3 (1983)]. Units used in the literature (if not SI) should be correctly converted.
9. The time allotted for the oral presentation of seminar is 20 minutes: additional 10 minutes are provided for questions and answers.
10. INCOMPLETE AND CARELESSLY WRITTEN REPORT IS LIABLE TO BE REJECTED.
11. The last date for submission will NOT be extended on any grounds whatsoever.
12. The Seminar will be evaluated on the basis of (i) rational approach to the problem, ii) correctness and completeness of the written text and iii) performance in the oral presentation.
13. Word-to-word copying from the published article is not permitted. Flowery language is not to be used.

The submitted report will be evaluated by the research guide and an external examiner from the Department/Industry based on the presentation made by the candidate. A suitable combination of the marks for report and presentation will be considered for the final evaluation.