VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICS ENGINEERING

M. Tech Biomedical Engineering

(M.Tech MBE)

Curriculum

(*2023-24 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

To be a leader by imparting in-depth knowledge in Electronics Engineering, nurturing engineers, technologists and researchers of highest competence, who would engage in sustainable development to cater the global needs of industry and society.

MISSION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

- Create and maintain an environment to excel in teaching, learning and applied research in the fields of electronics, communication engineering and allied disciplines which pioneer for sustainable growth.
- Equip our students with necessary knowledge and skills which enable them to be lifelong learners to solve practical problems and to improve the quality of human life.

M. Tech. Biomedical Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry

3. Graduates will function in their profession with social awareness and responsibility

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country

5. Graduates will be successful in pursuing higher studies in engineering or management

6. Graduates will pursue career paths in teaching or research

M. Tech Biomedical Engineering

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_02: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_03: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_04: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_05: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_06: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_07: Having a clear understanding of professional and ethical responsibility

PO_08: Having a good cognitive load management skills related to project management and finance

M. Tech Biomedcical Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M. Tech. (Biomedical Engineering) programme, graduates will be able to

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.

CREDIT INFO		
S.no	**Catagory**	**Credits**
1	Discipline Core	24
2	Discipline Elective	12
3	Projects and Internship	26
4	Open Elective	3
5	Skill Enhancement	5
6	Bridge Course	1
Total Credits		70

Discipline Core									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MBML503L	Biomedical Sensors and Data Acquisition Techniques	Theory Only	1.0	2	0	0	0	2.0
2	MBML503P	Biomedical Sensors and Data Acquisition Techniques Lab	Lab Only	1.0	0	0	2	0	1.0
3	MBML504L	Bio-signal Processing and Analysis	Theory Only	1.0	3	0	0	0	3.0
4	MBML504P	Bio-signal Processing and Analysis Lab	Lab Only	1.0	0	0	2	0	1.0
5	MBML508L	Medical Imaging Techniques	Theory Only	1.0	3	0	0	0	3.0
6	MBML510L	Biomedical Instrumentation and Measurements	Theory Only	1.0	3	0	0	0	3.0
7	MBML510P	Biomedical Instrumentation and Measurements Lab	Lab Only	1.0	0	0	2	0	1.0
8	MBML511L	Medical Image Analysis	Theory Only	1.0	3	0	0	0	3.0
9	MBML511P	Medical Image Analysis Lab	Lab Only	1.0	0	0	2	0	1.0
10	MBML602L	Biomaterials	Theory Only	1.0	3	0	0	0	3.0
11	MBML603L	Biomechanics	Theory Only	1.0	3	0	0	0	3.0

Discipline Elective									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MAME618L	Soft Computing Techniques	Theory Only	1.0	3	0	0	0	3.0
2	MBML509L	Health Care Management	Theory Only	1.0	3	0	0	0	3.0
3	MBML601L	Rehabilitation Engineering	Theory Only	1.0	3	0	0	0	3.0
4	MBML605L	Big Data Analytics in Medical Applications	Theory Only	1.0	3	0	0	0	3.0
5	MBML606L	MEMS and NEMS for Biomedical Applications	Theory Only	1.0	3	0	0	0	3.0
6	MBML607L	Physiological Control Systems	Theory Only	1.0	3	0	0	0	3.0
7	MBML609L	Networking and Information System in Medicine	Theory Only	1.0	3	0	0	0	3.0
8	MBML610L	Medical Robotics	Theory Only	1.0	3	0	0	0	3.0
9	MBML612L	Biomedical Laser Instrumentation	Theory Only	1.0	3	0	0	0	3.0
10	MEDS501L	Embedded System Design	Theory Only	1.0	3	0	0	0	3.0
11	MEDS616L	Machine Learning and Deep Learning	Theory Only	1.0	3	0	0	0	3.0

Projects and Internship									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	MBML696J	Study Oriented Project	Project	1.0	0	0	0	0	2.0
2	MBML697J	Design Project	Project	1.0	0	0	0	0	2.0
3	MBML698J	Internship I/ Dissertation I	Project	1.0	0	0	0	0	10.0
4	MBML699J	Internship II/ Dissertation II	Project	1.0	0	0	0	0	12.0

Open Elective									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	MFRE501L	Francais Fonctionnel	Theory Only	1.0	3	0	0	0	3.0
2	MGER501L	Deutsch fuer Anfaenger	Theory Only	1.0	3	0	0	0	3.0
3	MSTS601L	Advanced Competitive Coding	Soft Skill	1.0	3	0	0	0	3.0

Skill Enhancement									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	MENG501P	Technical Report Writing	Lab Only	1.0	0	0	4	0	2.0
2	MSTS501P	Qualitative Skills Practice	Soft Skill	1.0	0	0	3	0	1.5
3	MSTS502P	Quantitative Skills Practice	Soft Skill	1.0	0	0	3	0	1.5

Bridge Course									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	MBML501N	Anatomy and Physiology	Theory Only	1.0	1	0	0	0	1.0
2	MBML502N	Basic Electronics and Measurements	Theory Only	1.0	1	0	0	0	1.0

Course Code	Course Title	L	T	P	C
MBML501N	Anatomy and Physiology	1	0	0	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To define the basic concepts of anatomical and physiological terminologies relating tocell, 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.

Course Outcome

The students will be able to:

1. Comprehend the basic concepts of human cell and its organelles, general physiologicalconcepts, primary tissues and organ systems of the human body
2. Ability to understand the basic physiological function about endocrine, digestive and circulatory system.
3. Conceive the mechanism about the kidney function and urine formation.
4. Perceive the concepts about the body fluids and its circulatory pathways in human body.
5. Envisage the basic concepts on the human body mechanics, locomotion, bones and jointsinvolved in its movement.
6. Recognize the breathing mechanism, gaseous exchange, human neural system and itsconduction of nerve impulse.
7. Ability to understand the necessary information about the human body mechanism withits physiological functions

Module:1	Basics of Anatomy and Physiology	2 hours

Introduction to Human anatomy and physiology- Anatomical and medical terminology- Structureof the human cell – Four primary tissues, organs and organ systems – Physiology of homeostasis. Osteology and joints- Muscles.

Module:2	Blood and Body Fluids	2 hours

Body fluids- Composition and functions of blood- Plasma proteins- Red blood cells, White blood cells and platelets- Blood groups and blood clotting.

Module:3	Endocrine and Reproductive Systems	2 hours

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 reproductiveorgans, functions of oestrogen and progesterone

Module:4	Cardiovascular System	2 hours

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.

Module:5	Respiratory System	1 hours

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, Dyspnoea.

Module:6	Nervous System and Special Senses	2 hours

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		
Module:7	**Urinary System and Digestive System**	**3 hours**
Structures of urinary system (malphigian corpuscles, Proximal convoluted tubule, loop of Henle and Distal convoluted tubule), Functions of the kidney, Innervations of urinary bladder, Organsof digestive systems - Salivary secretion, gastric secretion and pancreatic secretion, Bile secretion and functions of liver. Absorption of food substances. Movements of digestive tract.		
Module:8	**Contemporary Issues**	**1 hour**
	Total Lecture hours:	**15 hours**

Text Book(s)	
1.	Anne Waugh, Allison Grant, "Ross and Wilson Anatomy and Physiology in Health and Illness"**,** 2014, 12th Edition, Churchill Livingstone, London.
Reference Books	
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

Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML502N	Basic Electronics and Measurements	1	0	0	1
Pre-requisite	NIL	Syllabus version			
		1.0			

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.

Course Outcome

The students will be able to

1. Analyze electric circuits using the circuit laws and to comprehend the I-V characteristics of diodes.
2. Gains ability to design amplifiers and voltage followers; comprehend the characteristics of op-Amps.
3. Cognize the various logic circuits and memory types; ability to synthesize logic circuits.
4. Comprehend the architecture and instruction sets and programming related to 8051 microcontroller.
5. Assimilate the properties of discrete and continuous time Fourier transforms.
6. Investigate, design and implement small projects, applying the basics acquired from the types of sensors and transducers

Module:1	Semiconductor Devices and Circuits	2 hours

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.

Module:2	Integrated Circuits	2 hours

Op-Amp Fundamentals, Practical Limitations of op-amps, Frequency compensation and stability, Gain bandwidth product, Voltage Follower, Introduction to Instrumentation amplifier.

Module:3	Digital Systems	2 hours

Basic Logic Circuit Concepts- Representation of Numerical Data in Binary Form - Combinatorial and Sequential Logic Circuits - Synthesis of Logic Circuits - Computer Organization – Memory Types.

Module:4	8051 Microcontroller	2 hours

Introduction to 8051 microcontroller and it's architecture - Memory organization - Instruction sets and assembly language programming - Programming timers – interrupts - I/O ports and serial port - I/O interfacing.

Module:5	Signals and Systems	2 hours

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.

Module:6	Sensors	2 hours

Resistive sensors- Potentiometers, Strain gages, Pressure resistive temperature detectors (RTD), Thermistors, Magneto resistors, Light dependent resistor (LDR). Capacitive

sensors- Variable capacitor, Differential capacitor. Inductive sensors - Variable reluctance sensors, Eddy current sensors, Linear variable differential transformers (LVDT), Variable transformers, Magneto- elastic and Magnetostrictive sensors.		
Module:7	**Biopotential Measurement**	**2 hours**
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 PhysiologicalParameters- Electrodes for ECG, EEG, EMG, EOG.		
Module:8	**Contemporary Issues**	**1 hour**
	Total Lecture hours:	**15 hours**

Text Book(s)	
1.	Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, "Microelectronic Theory and Applications", 2013, 6th edition, Oxford University Press, NewDelhi
2.	E.W Golding, F.C Widdis, "Electrical Measurements and Measuring Instruments", 2011, 1st edition, Reem Publications Pvt. Ltd, NewDelhi.
Reference Books	
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, NewDelhi.
6.	John. G. Webster and Halit Eren, "Measurements, Instrumentation and Sensors Handbook: spatial, mechanical, thermal and radiation measurements", 2014, 2nd edition, CRC Press,Florida.

Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML503L	Biomedical Sensors and Data Acquisition Techniques	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

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.

Course Outcomes

The student will be able

1. Perceive the origin of bio signals and their measurement
2. Prescribe a sensor type to measure a specific physiological parameter.
3. Describe the different Bio signals and their characteristics
4. Design signal conditioning circuit for specific biomedical signal.
5. Select a type of interface and data acquisition system for the given biomedical signal.
6. Identify the communication protocol for the given bio signal.
7. Develop graphical user interface for biomedical signal acquisition and analysis; Design a prototype of a medical device

Module:1	Bioelectrodes	7 hours

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.

Module:2	Physiological Transducers	6 hours

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.

Module:3	Biosensors-Chemical and Optical	6 hours

Antibody based biosensors, DNA based biosensor, Immunoassays for plant and animal pathogen detection, Enzyme linked immune-sorbent assays (ELISA), bio-luminioscent technologies for pathogen detection; Optical sources and detectors: LED, Photo-diode, p-i-n and avalanche photo diode, optical interferometers: basics of optical sensing and LASER; basics of magnetic sensing.

Module:4	Bioamplifiers	6 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, Macroshock and Microshock, Preventive measures to reduce shock hazards

Module:5	DAQ cards	6 hours

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.		
Module:6	**Interface Standards and PC Buses**	**6 hours**
RS232, RS422, RS485, GPIB, USB – Firewire - Backplane buses - PCI, PCI-Express, PXI, PXIExpress, VME, VXI - Ethernet –TCP/IP protocols.		
Module:7	**Virtual Instrumentation**	**6 hours**
Virtual instrument and traditional instrument, hardware and software-Building Graphical User interfaces for use in data acquisition - Graphical programming-Multi-channel data acquisition inLabVIEW		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
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, NewJersey.
Reference Books	
1.	Robert H King, "Introduction to Data Acquisition with LabVIEW", 2012, 2nd Edition, McGraw Hill, NewYork.
2.	Joseph Bronzino and Donal R. Peterson, Handbook of Biomedical Engineering, 2015, 4th Edition, CRC Press, Florida.

Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MBML503P	Biomedical Sensors and Data AcquisitionTechniques Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

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 specificsensor 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.

Course Outcome

The student will be able

1. Perceive the origin of bio signals and their measurement
2. Prescribe a sensor type to measure a specific physiological parameter.
3. Describe the different Bio signals and their characteristics
4. Design signal conditioning circuit for specific biomedical signal.
5. Select a type of interface and data acquisition system for the given biomedical signal.
6. Identify the communication protocol for the given bio signal.
7. Develop graphical user interface for biomedical signal acquisition and analysis.
8. Design a prototype of a medical device

List of Challenging Experiments (Indicative)

1.	Interface ECG electrodes with a PC, using virtual instrumentation platform to acquire ECG signal and determine the heart rate.	
2.	Design a pulse oximeter using optical sensors and interface it with a PC, using virtual instrumentation platform to measure peripheral pulse	
3.	Interface EMG electrodes with a PC, using virtual instrumentation platform to acquire the signal from different muscl es	
4.	Interface temperature sensor with data acquisition system to monitor the body temperature and calibrate the same	
5.	Interface hot wire anemometer with data acquisition system to measure the air flow rate and calibration of the same	
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: CAT/ FAT

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML504L	Bio-signal Processing and Analysis	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

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.

Course Outcome

The students will be able

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
4. EEG analysis and modelling
5. To familiarize the digital signal processor with its application aspects
6. Appreciate the operation of processors and its special applications
7. Acquaint the ECG processing and pattern recognition

Module:1	**Introduction to Biomedical Signal Analysis**	**3 hours**

Introduction to signals - Time domain - Statistical and information theoretic analysis.

Module:2	**Time-Frequency Domain Analysis**	**8 hours**

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.

Module:3	**Digital Filters**	**7 hours**

Types of artefacts and noise - Time domain filters, frequency domain filters, notch and comb filters, optimal filtering, adaptive filters - Signal decomposition based filtering.

Module:4	**Event Detection and Feature Extraction Techniques**	**7 hours**

Signal segmentation - Envelop extraction and analysis, temporal, spectral, statistical, information `theoretic and cross spectral features - Waveform complexity.

Module:5	**Digital Signal Processors**	**5 hours**

General purpo e DSP processors, architecture, hardware configuration, software development tools - Implementation considerations, fixed point DSP processors, floating point DSPprocessors.

Module:6	**TMS320 Family of DSP processors**	**7 hours**

Architecture - Functional units - Pipelining-Registers - Linear and Circular addressing – Types of instructions - Sample Programs - Real Time Implementation on DSP processors - Factors tobe considered for optimized implementation based on processor architecture: Implementation of simple Real Time Digital Filters, FFT using DSP - Overview of Black Fin Processors

Module:7	**Case Studies**	**6 hours**

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 - Mmatched and Wiener filter for filtering in ultrasound.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

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

	IEEE Press, New York.		
Reference Books			
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.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML504P	Bio-signal Processing and Analysis Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

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.

Course Outcome

The students will be able

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
4. EEG analysis and modelling
5. To familiarize the digital signal processor with its application aspects
6. Appreciate the operation of processors and its special applications
7. Acquaint the ECG processing and pattern recognition

List of Challenging Experiments (Indicative)

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?			
	Total Laboratory Hours			**30 hours**
Mode of Evaluation: CAT/ FAT				
Recommended by Board of Studies	28-07-2022			
Approved by Academic Council	No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MBML508L	Medical Imaging Techniques	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide comprehensive understanding of medical image acquisition in different modalities andthe 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.

Course Outcome

The student will be able

1. To comprehend the acquisition techniques involved in different modalities of medical imaging
2. To conceive the historical evolution of the imaging methods pertaining to computed tomography
3. To excel with different reconstruction techniques and programming techniques for noise removal.
4. To manipulate of acoustic radiation fields for diagnostics to be skillful in image generation
5. Establish the principle of operation and modules employed in magnetic resonance imaging
6. Able to develop decision-making capabilities with respect to diagnostic imaging
7. To compare the available processes, validate and interpret the medical images for a givenapplication

Module:1	X-ray Projection Imaging	7 hours

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.

Module:2	X ray Computed Tomography	6 hours

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

Module:3	Radio Isotopic Imaging	6 hours

SPECT- Radiation detectors, Radionuclides for imaging, Gamma ray camera, scanners, Positron Emission tomography - Iterative reconstruction algorithms, SPECT/CT,PET/CT registration

Module:4	Ultrasonic Systems	6 hours

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

Module:5	Magnetic Resonance Imaging	6 hours

NMR - Principles of MRI, Relaxation processes and their measurements, Pulse sequencing and MRimage acquisition, Image reconstruction, Functional MRI, Diffusion imaging, EPI.

Module:6	Optical and other imaging modalities	6 hours

Microscopic imaging principle and applications - Optical coherence tomography, principle, applications - Endoscopic image processing and applications - Electrical source imaging -

Electrical impedance tomography - Microwave imaging			
Module:7	**Image processing for medicine**		**6 hours**
Image segmentation - Computational anatomy - Registration of multi-modality images – Synthesis of parametric images - Data visualization - Treatment planning			
Module:8	**Contemporary Issues**		**2 hours**
		Total Lecture hours:	**45 hours**
Text Book(s)			
1.	M A Flower, “Webb's Physics of Medical Imaging”, 2016, 2nd Edition, CRC Press, Florida		
Reference Books			
1.	Jerry L. Prince and Jonathan M. Links, “Medical Imaging Signals and Systems”, 2014, 2ndEdition Pearson Education Inc., London		
2.	Paul Suetens, “Fundamentals of Medical Imaging”, 2017, 3rd Edition, Cambridge UniversityPress, Cambridge.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML510L	Biomedical Instrumentation and Measurements	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1.0			

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.

Course Outcomes

The students will be able to

1. Envision the design of various bio potential recording equipment and its applications
2. Comprehend the working principle and applications of the analytical equipment used in medical field.
3. Perceive the advantages and disadvantages of the different types of flowmeters and radiation detectors; limits of usage.
4. Develop first end devices for cardiology applications and to monitor respiratory parameters.
5. Summarize the variety of dialysis units, its supporting facilities and various kinds of dialyzers.
6. Intuit the application of physiotherapy and surgical equipment; range of operation.
7. Design, connect, operate and trouble shoot the biomedical equipment.

Module:1	Bio Potential Recording	6 hours

Introduction to ECG, EEG, EMG, PCG, EOG, lead system and recording methods, typical waveform, frequency spectrum, abnormal waveforms. Evoked response, Electroencephalography, Electrocardiography, Electromyography.

Module:2	Analytical & Diagnostic Instruments	6 hours

Common analytical equipment used in hospitals and those in Biochemistry laboratories – Blood Flow meters: Ultrasonic blood flow meters, NMR blood flow meter, Laser Doppler blood flow meters - Pulmonary function analyzers - Blood gas analyzers - Different types of Oximetry systems - Pulse oximeter, Blood pressure measurement - Blood cell counters

Module:3	Radiation Detectors and Cardiac Devices	6 hours

Radiation detectors, Pulse height analyzer, Gamma camera, Medical ultrasound, Basic pulse echo apparatus-External and Implantable Pacemaker– DC defibrillator, Modes of operation and electrodes, Performance aspects of dc- defibrillator, Implantable defibrillator, defibrillator analyzers- Heart lung machine

Module:4	Hemodialysis Machine	6 hours

Basic principle of Hemodialysis and its type - Membrane, Dialysate, Different types ofhemodialyzers, Monitoring Systems, Portable and Wearable Artificial Kidney, Implanting Type -Different types of dialyzer membrane.

Module:5	**Physiotherapy and Surgical Instruments**	**6 hours**
Basic principle, working and technical specifications of Shortwave Diathermy - Ultrasonic therapy unit, Infrared and UV lamps - Nerve and Muscle Stimulator - Surgical Diathermy machine, Electrodes used with surgical diathermy, Safety aspects in electronic surgical units, Surgical diathermy analyzers.		
Module:6	**Ventilators and Anaesthesia System**	**6 hours**
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.		
Module:7	**Standards for Hospitals**	**7 hours**
Voluntary & Mandatory standards, General standards, Mechanical standards, Electrical Standards, Standard for centralized medical gas system, Standards for biomedical waste		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	R S. Khandpur, "Handbook of Biomedical Instrumentation", 2014, 3rd Edition, Tata McGraw Hill, New Delhi.
2.	John G. Webster, "Medical Instrumentation Application and Design", 2015, 4th Edition, John Wiley and sons, New Jersey
Reference Books	
1.	Carr –Brown, "Introduction to Biomedical Equipment Technology", 2011, 1st Edition, Pearson, New York

Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MBML510P	Biomedical Instrumentation and Measurements Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Discuss and express the basic principle, working and design of various bio potential recordingequipment
2. To acquaint the students with the different patient monitoring and therapeutic systems available for use in medical field.
3. To provide comprehensive understanding of medical image acquisition in different modalities and the historical evolution of these imaging methods.
4. 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

Course Outcomes

The students will be able to

1. Envision the design of various bio potential recording equipment and its applications
2. Comprehend the working principle and applications of the patient monitoring system.
3. Develop first end devices for cardiology applications and to monitor physiological parameters.
4. To comprehend the acquisition techniques involved in different modalities of medical imaging
5. Establish the principle of operation and modules employed in magnetic resonance imaging.
6. Intuit the application of therapeutic, patient-support and surgical equipment; range of operation.
7. Design, connect, operate and trouble shoot the biomedical equipment.

Indicative Experiments	
1.	Analyze Instrumentation amplifier for biomedical signals
2.	Design pulse oximeter and segregate the second derivative to detect Heart ailments.
3.	Design an ECG set-up to record three lead ECG and measure the R-R interval, Heart Rate and the cardio vector.
4.	Simulate the real time EEG monitoring and measure the amplitude and frequency of Alpha, Beta, Gamma and Delta waves.
5.	Design and develop a hearing aid to improve the hearing capability.
Total Laboratory Hours	**30 hours**

Text Book(s)

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

Reference Books			
1.	Carr –Brown, "Introduction to Biomedical Equipment Technology", 2011, 1st Edition, Pearson, New York		
Mode of assessment: Continuous assessment / FAT / Oral examination and others			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MBML511L	Medical Image Analysis	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide a comprehensive understanding of the image acquisition and processing.
2. To become familiar with image enhancement and segmentation methods.
3. To develop a specific application using current techniques for improving and extracting information from videos.

Course Outcomes

Student is expected to:

1. Comprehend image sampling and DFT
2. Process the given medical images to enhance them
3. Apply compression techniques and morphological operations for segmentation
4. Predict a machine learning algorithm on the given image for segmentation
5. Register images of different modalities, render their volumes for visualization
6. Use neural networks for image classification
7. Design and develop machine learning methods in medical image computing

Module:1	Image processing and Image Transforms	6 hours

Mathematical imaging models for physical signals, sampling, noise and artefact models. Signal modelling and model fitting. Sampling and quantization of an Image – Basic relationship between pixels Image Transforms: 2 – D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet transforms

Module:2	Noise removal, image restoration and reconstruction	7 hours

Image Enhancement- spatial methods -Histogram Processing, Smoothing Spatial filters, Sharpening Spatial filters degradation models for corrupted and missing data, Bayesian graphical modeling and inference, regression methods, learning based methods.

Module:3	Image segmentation, object delineation, classification	7 hours

Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds - clustering, graph partitioning, classification, mixture models, expectation maximization, hidden Markov random fields, multivariate Gaussian, kernel methods, variational methods using geometric and statistical modeling, abnormality detection, image categorization

Module:4	Statistical shape analysis	7 hours

Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching. shape spaces, learning shape models, learning shape mean and modes of variation – identifying human organs and substructures

Module:5	Image registration	7 hours

Similarity models, deformation models, energy functions, optimization algorithms. - anatomical atlas generation, co-registration, motion correction.

Module:6	2-D Motion Estimation	6 hours

General methodologies, pixel-based motion estimation, Block matching algorithm, Mesh based motion Estimation, global Motion Estimation, Region based motion estimation, multi resolution motion estimation. Application of motion estimation in cine radiography		
Module:7	**Machine learning methods in Medical image computing**	**5 hours**
Computer aided diagnosis – segmentation using adversarial networks – image registration using machine learning- Lesion detection using machine learning		
Module:8	**Contemporary Issues**	**2 hours**
	Total Hours	**45 hours**

Text Book(s)	
1.	S. Kevin Zhou, Daniel Rueckert, Gabor Fichtinger, Handbook of Medical Image Computing and Computer Assisted Intervention, Academic Press, 2020
2.	Gonzalez and Woods ,"Digital Image Processing ", 3rd edition , Pearson
Reference Books	
1.	Y. Wang, J. Ostermann, and Y.Q.Zhang, Video Processing and Communications. Prentice Hall, 2002
2.	Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Sons.
3.	Christopher Bishop. Pattern Recognition and Machine Learning, Springer 2006.
4.	Paul suetens, 'Fundamentals of medical imaging', Cambridge University Press, 2002.

Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MBML511P	Medical Image Analysis Lab	0	0	2	1
Prerequisite	NIL	Syllabus Version			
		1.0			

Course Objectives

1. To define the principles of image sampling, quantization, enhancement and filteringtechniques
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 medicalapplications
4. To acquire the student with the techniques of shape analysis and image classification using neural networks for brain computer interface and computer aided diagnosis.

Course Outcomes

The student will be able

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

Indicative Experiments	
1.	Using spatial filters 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 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 the given PET and CT image and register them.
	Total Laboratory Hours | **30 hours**

Text Book(s)

1.	S. Kevin Zhou, Daniel Rueckert, Gabor Fichtinger, Handbook of Medical Image Computing and Computer Assisted Intervention, Academic Press, 2020
	Gonzalez and Woods ,"Digital Image Processing ", 3rd edition , Pearson

Reference Books

1.	Y. Wang, J. Ostermann, and Y.Q.Zhang, Video Processing and Communications. Prentice Hall, 2002
2.	Chris Solomon, Toby Breckon ,"Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab", John Wiley & Sons.

3.	Christopher Bishop. Pattern Recognition and Machine Learning, Springer 2006.			
4.	Paul suetens, 'Fundamentals of medical imaging', Cambridge University Press, 2002.			
Mode of assessment: Continuous assessment / FAT / Oral examination and others				
Recommended by Board of Studies	07-06-2023			
Approved by Academic Council	No. 70	Date	24-06-2023	

Course Code	Course Title	L	T	P	C
MBML602L	Biomaterials	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide a comprehensive understanding of materials and their properties used in healthcare.
2. To become familiar with different type of biomaterials and their functional ability in healthcare.
3. To acquire knowledge and insights on the different characterization techniques used for biomaterial analysis.

Course Outcomes

Student is expected to:

1. To understand the fundamental and basics of biomaterials
2. Analyze the different types and functions of biomaterials used in healthcare.
3. To equip in-depth knowledge about scaffolding and its significance in healthcare.
4. Analyze the different and conventional methods of additive manufacturing involved in biomaterials.
5. To acquire knowledge on the various techniques involved in the characterization of biomaterials.
6. To acquire knowledge on the cell-material interaction and their biological properties.

Module:1	Materials for Biomedical Applications	4 hours

Conceptual evolution of biomaterials, Classification of Biomaterials based on biocompatibility and host response, Biodegradable polymer scaffolds, bioactive glasses and ceramics, Generic classification of biomaterials – Metallic biomaterials, bioceramics, biopolymers, biocomposites.

Module:2	Tissue Engineering Scaffolds: Principles and Properties	5 hours

Structure and properties of bone, Property requirements for bone tissue engineering scaffolds, Overview of biological and porous scaffolds, Routes to enhance biocompatibility – Surface functionalization of bioceramics & biopolymers, Biofunctionalization, Biocompatibility of patterned/textured biomaterial surfaces

Module:3	Mechanical Properties: Principles and Assessment	6 hours

Conceptual understanding of stress and strain, Stress-strain response of metals, Tensile deformation behaviour, Strengthening of metals, brittle fracture of ceramics, Mechanical properties of polymeric biomaterials, Experimental assessment of mechanical properties – Metals, Ceramics, Polymers, Practical guidelines for the experimental measurements – Hardness, Strength, Fracture toughness, Elastic modulus.

Module:4	Conventional and advanced manufacturing biomaterials	6 hours

Conventional manufacturing of metallic biomaterials – Casting, Bulk deformation process, Metal joining process, Machining process, Heat treatment, Processing of Ceramics - Sintering mechanism, Consolidation and shaping of polymers, Patient-specific implant fabrication using additive manufacturing, 3D powder printing, 3D plotting, post-processing.

Module:5	Probing structure of materials at multiple length scales	6 hours

Spectroscopic analysis – IR spectroscopy, Raman spectroscopy, Crystal structure and compositional analysis – X-ray diffraction, X-ray photoelectron spectroscopy,		
Module:6	**Imaging techniques for microstructure characterization**	**8 hours**
Atomic Force microscopy, Scanning electron microscopy, Transmission electron microscopy, 3D structural characterization using X-ray micro computed tomography, Electrical characterization – Electrical impedance spectroscopy, Magnetic characterization – vibrating sample magnetometry.		
Module:7	**Cell-Material Interaction and Biocompatibility**	**8 hours**
Biophysical processes involved in biocompatibility, Cell-material interaction, Cell adhesion and cell morphological changes, Cell signalling mechanism, Classification of signalling mechanisms, quantitative analysis and intracellular signalling mechanism, Cell differentiation, Cell migration, Cell division, Cell death, Qualitative and quantitative assessment of cell morphology – Fluorencence microscopy, confocal microscopy.		
Module:8	**Contemporary Issues**	**2 hours**
Total Hours		**45 hours**

Text Book(s)	
1.	Bikramjit Basu, 'Biomaterials Science and Tissue Engineering: Principles and Methods', Cambridge University Press, 2017.
Reference Books	
1.	Euth Ortiz Ortega · Hamed Hosseinian, Ingrid Berenice Aguilar Meza, María José Rosales López, Andrea Rodríguez Vera, Samira Hosseini., "Material Characterization techniques and applications" Progress in Optical Science and Photonics, Volume 19, Springer, 2022.
2.	Yang Leng., "Materials Characterization", 2nd edition, Wiley-VCH Verlag GmbH & Co.
Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.	

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MBML603L	Biomechanics	3	0	0	3
Prerequisite		Syllabus version			
		1.0			

Course Objectives

1. To get familiarised with the mechanics of human body, study the properties of bone and soft tissues like skeletal muscles, articular cartilage, tendons and ligaments.
2. To gain knowledge about accidents, injuries, posture, gait and their abnormalities.
3. To explore various assistive devices that can be used in biomechanics for correcting various injuries and abnormalities.

Course Outcomes

1. To gain knowledge on basic concepts of biomechanics, terminologies and understand about bones, joints, soft tissues like ligaments, cartilages, tendons.
2. To conceptualize on muscle action and mechanics.
3. To familiarise on kinetics and kinematics like linear, angular motions and inverse dynamic analyses.
4. To gain insight on balance, coordination, normal and pathological postures and gait patterns.
5. To comprehend and analyse the mechanism of various biomechanical injuries and their ergonomic considerations.
6. To design and analyse various assistive devices. and implants for biomechanical needs.

Module:1	**Concepts of biomechanics**	**8 hours**
Basics of Bio-mechanics – definition, terminologies, skeletal system, bones and joints, structure and function of skeletal muscles, levers.		
Module:2	**Muscle action and mechanics**	**6 hours**
Muscle mechanics and modelling, muscle action and statics, principle of statics, static analysis of elbow, shoulder, spine, hip, knee and ankle.		
Module:3	**Kinetics and dynamic analysis**	**6 hours**
Linear motion and angular motion, kinetics of arm swinging, inverse dynamic analysis.		
Module:4	**Posture and Gait**	**8 hours**
Normal and abnormal postures, Normal Gait pattern, pathological gait patterns, balance, coordination, and factors that affect balance and coordination.		
Module:5	**Biomechanical injuries and ergonomics**	**5 hours**
Occupational, traumatic, sports and spontaneous injuries. Mechanism of injuries and ergonomic considerations.		
Module:6	**Assistive devices and orthopaedic implants**	**5 hours**
Assistive devices and the materials used in their manufacturing, considerations for orthopaedic implants.		
Module:7	**orthopaedic designs: Design and analysis**	**5 hours**
Overview on orthopaedic designs, Use of CAD tools in modelling and analysis.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Hours	**45 hours**

Text Book(s)

1.	Susan J.Hall, "Basics Biomechanics", 2022, 9th Edition, McGraw-Hill Education, New York.
2.	Pamela K. Levangie and Cynthia C. Norkin, "Joint Structure and Function: A Comprehensive Analysis", 2019, 6th Edition, F.A. Davis Company.
Reference Books	
1.	Duane Knudson, "Fundamentals of Biomechanics", 2021, 3rd Edition, Springer Publications.
Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.	
Recommended by Board of Studies	07-06-2023
Approved by Academic Council	No. 70 Date 24-06-2023

Course Code	Course Title	L	T	P	C
MBML509L	Healthcare Management	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide a comprehensive understanding of healthcare management and its strategic planning.
2. To become familiar with different type of organizational behavior and healthcare marketing.
3. To acquire knowledge and insights about Lego-ethical issue in healthcare regulations and its compliance.

Course Outcomes

Student is expected:

1. To understand the fundamental and basics of Healthcare Management
2. Analyze the different roles and responsibilities of management and its motivation.
3. To analyze on different organizational behaviors and it social intelligence.
4. To understand about strategic planning in healthcare marketing.
5. To acquire knowledge about different Health information systems in healthcare.
6. To acquire knowledge in Law and ethics to be followed in healthcare regulations.

Module:1	An Overview of Healthcare Management	4 hours

Management: Definition, Functions and competencies, management positions, Focus of management, Role of managers in Self, Unit and Team organization, Talent management, Strategic planning and development, Ensuring high performance, Innovation and change management.

Module:2	Leadership, Management and Motivation	5 hours

Leadership vs Management, Leadership styles, competencies and protocols, Governance, ethical responsibility, Opportunities for research on health care leadership, Motivated vs Engaged, misconceptions about motivation and employee satisfaction, motivational and engagement strategies.

Module:3	Organizational Behavior and Management Thinking	8 hours

The field of organizational behavior, Contribution to Management, Key topics, Thinking: "Inner game", Four key features of thinking, Mental representation, processing information, Decision making, social cognition and socio-emotional intelligence, social categorization and biases, implications of social cognition and socio-emotional intelligence.

Module:4	Strategic Planning and Healthcare Marketing	7 hours

Purpose and importance of strategic planning, Planning process, SWOT analysis, Rollout and implementation, Strategy execution, key components of marketing concept, understanding marketing management, Health care buyer behavior, Marketing Mix, Marketing Plan, Ethics and social responsibility, Outcomes of marketing, Opportunities for research on healthcare marketing.

Module:5	Sensor Network Architecture	7 hours

Healthcare information systems used by managers, Evolution of EMR's, Challenges to clinical system adoption, Impact of information technology on healthcare manager, Licensed practical and nursing assistants, Home health aides and

personal care aides, Midlevel practitioners, Healthcare organizations and sexual harassment.		
Module:6	**Strategic Management of Human resources and Teamwork**	**8 hours**
Environmental forces affecting Human resources management, Understanding employees as Drivers of organization performance, Key function of Human Resources, workforce planning and recruitment, employee retention, Challenges of teamwork in healthcare organizations, Benefits of effective health care teams, Costs of teamwork, Real-world problems, Team communications and its methods.		
Module:7	**Law, Ethics, Healthcare Regulations and Compliance**	**5 hours**
Legal concepts, Healthcare law, Tort Law, Malpractice, Contract Law, Ethical concepts, Biomedical concerns, Beginning- and End-of -Life care, False claims act, Anti-Kickback statute, Social security act exclusion statute, Civil Monetary Penalties Law, Antirust issues, Corporate Compliance programs.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Hours	**45 hours**

Text Book(s)	
1.	Sharon B. Buchbinder., Nancy H.Shanks,m Bobbie J.Kite., "Introduction to Health Care Management", 4th edition., Jones & Bartlett Learning, 2019.
Reference Books	
1.	Govind Madhav., Santosh kumar., "Handbook of Hospital Administration", Elsevier., 2018
Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.	

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MBML601L	Rehabilitation Engineering	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To get familiarised with the concepts of rehabilitation and assistive device technology
2. To bridge the gap between technology and delivery of rehabilitation care
3. To get better understanding about motor, sensory, paediatric, geriatric and psychosomatic disorders

Course Outcomes

1. To understand the terms, concepts, members, legal aspects related to rehabilitation and the disability act
2. To get adequate knowledge on selection of materials, design considerations, fabrication process, technological base for development of orthoses and prostheses.
3. To familiarise on motor rehabilitation and wearable assistive devices
4. To familiarise on sensory rehabilitation, devices for sensory augmentation and substitution
5. To familiarise on the needs of paediatric and geriatric patients
6. To provide rehabilitative solutions to patients with psychosomatic disorders

Module:1	Concepts of rehabilitation	7 hours
Terminologies in rehabilitation medicine, legal aspects and disability act, concepts associated with rehabilitation, members of rehabilitation team.		
Module:2	**Rehabilitative aids and technology**	**7 hours**
Orthoses and prostheses – selection of materials, design considerations, fabrication process; technological advancement in rehabilitation devices – usage, manufacturing, designing; Wearable devices.		
Module:3	**Motor rehabilitation**	**7 hours**
Motor unit, motor pathway, muscular pathologies, bone fractures and joint injuries; assistive devices used in motor rehabilitation and their fabrication process.		
Module:4	**Sensory rehabilitation**	**7 hours**
Somato sensory pathway, pathological conditions of somato-sensory pathway; Special senses – Hearing and Vision, pathways, pathologies; augmentation and substitution.		
Module:5	**Paediatric rehabilitation**	**5 hours**
Understanding about paediatric problems – cerebral palsy, autism, muscular dystrophy; design consideration and development process of devices for paediatric patients.		
Module:6	**Geriatric rehabilitation**	**5 hours**
Understanding about geriatric problems – bed riddance and mobility disorders, stroke, parkinsonism, Alzheimer's disease; design consideration and development process of devices for geriatric patients.		
Module:7	**Rehabilitation of psychosomatic disorders**	**5 hours**
Psychological disorders – insomnia, anxiety, depression; Cognitive disorders and speech dysarthria; Overview on music and speech therapies, Devices for psychosomatic disorder and other cognitive pathologies.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Hours	**45 hours**

Text Book(s)			
1	Alex Mihailidis and Roger Smith, "Rehabilitation Engineering – Principles and Practice", 2023, 1st Edition, CRC Press		
2	Rory A, Cooper, Hisaichi Ohnabe, Douglas A, Hodson, "An Introduction to Rehabilitation Engineering", 2006, 1st Edition, CRC Press		
Reference Books			
1.	Suzanne Robitaille, "The illustrated guide to Assistive technology and devices-Tools and gadgets for living independently", 2010, 1st Edition, Demos Health Newyork		
Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MBML605L	Big Data Analytics in Medical Application	3	0	0	3
Prerequisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To study basics of biological Neural Network
2. To understand the basics of artificial Neural Network
3. To study different pattern recognition task using ANN

Course Outcome:

The student will be able to

1. Acquire the information about components of biological neurons namely, the dendrites, the axons and the cell body.
2. Will be expedient in the concepts and classify the features of fundamental neural network models such as perceptron, McCulloch Pitts, and ADALINE.
3. Understand and analysis the mechanism of back propagation in neural networks along with importance of tuning parameters.
4. Elaborate on concepts of Activation and Synaptic dynamics.
5. Understand the basics of competitive learning neural network, pattern recognition and pattern mapping.
6. Understand the basic gradient search methods, stochastic networks and machine learning based optimization mechanisms.
7. Visualize the components of competitive learning neural networks and to differentiate the features of ART models.
8. Develop real-time working prototypes of different small-scale and medium-scale artificial neural network based systems to address Engineering challenges.

Module :1	Introduction to ANN	6 hours
Introduction: Introduction to medical Data Analytics- Electronic Health Records– Components of EHR- Coding Systems- Benefits of EHR- Barrier to Adopting EHR- Challenges- Phenotyping Algorithms.		
Module:2	**Basics of Artificial Neural Networks**	**6 hours**
History of neural network research, characteristics of neural networks terminology, models of neuron McCulloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture		
Module:3	**Back propagation Networks**	**6 hours**
Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, back propagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning.		
Module:4	**Activation & Synaptic Dynamics**	**6 hours**
Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks.		
Module:5	**Functional units of ANN for Pattern Recognition Tasks:**	**6 hours**
Basic feed forward, Basic feedback and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks		
Module: 6	**Feedforward & Feedback Neural Networks**	**6 hours**
Analysis of pattern mapping networks summary of basic gradient search methods. Pattern storage networks, stochastic networks and simulated annealing, Boltzmann machine and Boltzmann learning		
Module: 7	**Application of ANN**	**6 hours**

Components of CL network pattern clustering and feature mapping network, ART networks, Features of ART models, character recognition using ART network, Pattern recognition, segmentation, classification.		
Module:8	**Contemporary Issues**	**3 hours**
Total Lecture hours:		**45 hours**
Text Book		
1. Hagan, Demuth and Beale, “Neural network design”, 2014, 1st Edition, Vikas Publishing House Pvt Ltd., New Delhi, India.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT		
Recommended by Board of Studies	28-07-2022	
Approved by Academic Council	No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MBML606L	MEMS and NEMS for Biomedical Applications	3	0	0	3
Prerequisite:	NIL	Syllabus Version			
		1.0			

Course Objectives

1. Introduce and discuss the historical background of evolution of MEMS and Biosensors.
2. Comprehend effects in miniaturizing devices and discuss various modern micromachining techniques for realization of MEMS as well as microfluidic based biosensors.
3. Discuss and understand applications of Biosensors and Microfluidics in the Healthcare domain and importance of miniaturization for the same.
4. Acquaint with various CAD tools and its importance to understand development of BioMEMS and microfluidic lab-on-chip sensors.

Course Outcomes

The student will be able to

1. Acquaint the historical background of evolution of MEMS and Biosensors.
2. Understand the scaling effects in different Physical domains on miniaturized devices.
3. Comprehend the understanding of various modern micromachining techniques and device
4. Fabrication.
5. Acquaint with the fundamental concepts of Biosensor development and Microfluidics Lab-on-chip devices.
6. Incept various applications of MEMS and Biosensors in healthcare domain and get acquainted with the latest trends in the field.
7. Design and simulation through Application specific CAD tools to create microfluidic devices for BioMEMS and Microfluidic applications.

Module:1	Introduction to MEMS and Biosensors	4 hours

MEMS and Microsystems. Evolution of Microfabrication. Microsystem Design – Multidisciplinary nature of Microsystem design. Microsystems and miniaturization - Technology involved in MEMS. Introduction to Biosensors and Microfluidics.

Module:2	Scaling	4 hours

Scaling in Geometry-Scaling in Rigid, Body Dynamics, Scaling in Electromagnetic and Electrostatic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.

Module:3	Micro Machining Technology	10 hours

Introduction, Materials used- Substrates, wafers, silicon as a substrate material, Thin film deposition – PVD, CVD, Photolithography, Ion Implantation, Diffusion, Oxidation, Etching, Wafer bonding, Lift-off Process, Micromachining – Bulk micro-machining, Surface micro-machining, LIGA process.

Module:4	BioMEMS and Microfluidic Lab-on-Chip Systems	8 hours

Fundamentals of BioMEMS, Soft lithography. Basics of Fluid Mechanics, Microfluidic Lab-On-a-Chip Platforms, Important consideration on micro-scale fluid, Properties of fluid, Electrokinetics, Fluid actuation methods - Microvalves, Micropumps-mechanical (membrane type) and non-mechanical (electrical-electroosmosis, electrophoretic, DEP, EHD). Fabrication of Microfluidic channels.

Module:5	Applications of BioMEMS and Microfluidics	5 hours

Applications of MEMS in healthcare industry. Case Studies: Drug delivery systems, Cell-Based Chips for Biotechnology -Cell sorting and Trapping using DEP, BioMEMS for Cell Biology, Implantable Microelectrodes – Neural prosthesis, Micro needles; Micro-tools for Surgery - catheter end sensors.		
Module:6	**Biosensors and its Future**	**6 hours**
Electrode Fabrication, Electrochemical Detection Techniques-Amperometric, Potentiometric, Conductimetric, Impedimetric; Applications- Enzymatic-Based LOC Biosensors, Enzyme immobilization techniques, Antibodies-Based LOC-Biosensors, Cell-Based LOC-Biosensors. Applications of Paper Based Diagnostics. Future trends- Flexible and epidermal sensors.		
Module:7	**Microsystems Design**	**6 hours**
CAD Tools for MEMS Design, Introduction to Finite Element Method, Design and fabrication of Physical Sensors – Microheaters, Micropressure sensors, Design and fabrication of Microfluidic Network Systems.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Hours	**45 hours**

Text Book(s)	
1	Tai-Ran Hsu, "MEMS & Microsystem, Design and Manufacture",2020, 2nd Edition, John Wiley & Sons, Inc.
2	Jaime Castillo-León, Winnie E. Svendsen (eds.) "Lab-on-a-Chip Devices and Micro-Total Analysis Systems_ A Practical Guide", 2015, Springer International Publishing
Reference Books	
1.	Albert Folch, "Introduction to BioMEMS", 2012, 1st Edition, CRC Press, Florida.
2	Francis E. H. Tay, "Microfluidics and BioMEMS Applications", 2013, 1st Edition, Springer New York.
Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.	

Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course Code	Course Title	L	T	P	C
MBML607L	Physiological Control Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

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 analysing 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.

Course Outcome

The students will be able to

1. Comprehend the basic system concepts and differences between an engineering and physiological control systems.
2. Understand the application of various mathematical techniques in designing a bio-control system.
3. Analyze a given system in time domain and frequency domain.
4. Comprehend the techniques of plotting the responses in both the domain analysis.
5. Apply time domain and frequency domain analysis to study the biological systems.
6. Identify and optimize the physiological control systems.

   Develop simple models of the physiological control systems and analyze its stability.

Module:1	Introduction to Physiological Control Systems	7 hours

Introduction-Systems Analysis: Fundamental concepts – Physiological control systems analysis: simple examples – Difference between engineering and physiological control systems.

Module:2	Mathematical Modeling	6 hours

Generalized system properties – Models with combinations of systems elements – Linear models of physiological systems – Laplace transform and transfer functions.

Module:3	Time Domain Analysis of Linear Control Systems	6 hours

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.

Module:4	Frequency Domain Analysis of Linear Control Systems	6 hours

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.

Module:5	Stability Analysis	6 hours

Stability and Transient Response - Root Locus Plots - Routh - Hurwitz Stability Criterion - Nyquist Criterion for Stability - Relative Stability - Stability Analysis of the Pupillary light Reflex - Model of Cheyne-Stokes Breathing.

Module:6	Identification of Physiological Control Systems	6 hours

Basic problems in physiological system analysis-Non parametric and parametric identification methods-Problems in parameter estimation: Identifiability and input design-Identification ofclosed loop systems.

Module:7	Optimization in Physiological Control	6 hours

Optimization in systems with negative feedback – single parameter optimization: control of respiratory frequency – Constrained optimization: Airflow pattern regulation –constrained optimization: control of Aortic flow-Adaptive control of physiological variables.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
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 Books	
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.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML609L	Networking and Information System in Medicine	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Introduce fundamentals of data communication and principles of multimedia
2. Discuss the overview of available networks for telemedicine
3. Express the knowledge of tele medical standards, mobile telemedicine and its applications
4. Develop the basic parts of Tele radiology Systems like Image Acquisition System, DisplaySystem, Communication Network, Interpretation

Course Outcome

1. Comprehensive coverage to concepts of Telemedicine
2. To apply multimedia technologies telemedicine
3. Develop a protocols behind encryption techniques for secure data transmission
4. Students will acquire a basic knowledge about the hospital at home and remote diagnostics
5. Understand the often complex legal, regulatory and reimbursement in telemedicine
6. Able to identify and address the sociotechnical factors in telehealth

Module:1	Introduction to Networking	7 hours

Introduction, System Components, Networked Communities, Host Management, User Management- Application Level Services, Network Level Services, Principles of Security,Security Implications, and Analytical System Administration.

Module:2	Communication Network and Services	6 hours

Types of information: Audio, Video, Still Images, Text and data, and Fax - Types of Communication and Network: PSTN, POTS, ATN, and ISDN - Basic concepts of Communication and Network: Internet, and Wireless communications.

Module:3	Standards for Data Exchange	6 hours

Real-time Telemedicine. Data Exchange: Network Configuration, circuit and packet switching, H.320 series (Video phone based ISBN) T.120, H.324 (Video phone based PSTN). VideoConferencing.

Module:4	Hospital Management	6 hours

Need for HMIS, Capabilities & Development of HMIS, functional area, modules forming HMIS, (like Pathology Lab, Blood bank, Pharmacy, Diet planning).

Module:5	Hospital Information System	6 hours

Maintenance and development of HMIS-Ideal Features and functionality of CPR, Development tools for CPR.

Module:6	Picture Archival Communication Systems (PACS)	6 hours

Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication, Computer aided diagnosis (CAD), Centralized Database.

Module:7	Recent Trends in Medical Healthcare Management	6 hours

Impact of Systems on Health Care, Care Providers and Organizations, mobile health care technologies.

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	45 hours

Text Book(s)

1. A.S. Tanenbaum, “Computer Networks”, 2012, 5th Edition, Pearson Education, London.
2. Kenneth R. Ong, “Medical Informatics: An Executive primer”, 2015, 1st Edition, HIMSS

	Publishing, Chicago.			
Reference Books				
1.	Bernard Fong, A.C.M. Fong and C.K. Li, "Telemedicine Technologies: Information Technologies in Medicine and Tele-health", 2011, 1st Edition, Wiley-Blackwell, New Jersey.			
2.	Lazakidu, "Web-based Application in Healthcare and Biomedicine", 2012, 1st Edition, Springer, New York.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT.				
Recommended by Board of Studies	28-07-2022			
Approved by Academic Council	No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MBML610L	Medical Robotics	3	0	0	3
Prerequisite:	NIL	Syllabus Version			
		1.0			

Course Objectives

1. To study the kinematics, dynamics and various motion planning and control of robotics.
2. To understand the importance of medical automation and medical robotics.
3. To learn about prospective robotic systems for potential surgical interventions.

Course Outcomes

1. Have an understanding of the basics of robotics
2. Discover the kinematics and dynamic involved in design of robotic systems
3. Determine the path and plan a trajectory for a mobile system
4. Understand the importance of robotics in the field of Neuro surgery.
5. Understand the importance of robotics in the field of ortho surgery.
6. Focus on ethical challenges for medical robotics.

Module:1	Introduction	3 hours

Mathematical Modeling of Robots, Robots as Mechanical Devices, Common Kinematic Arrangements

Module:2	Rigid Motions and Forward Kinematics	8 hours

Representing Positions, Representing Rotations, Rotational Transformations, Composition of Rotations, Parameterizations of Rotations, Rigid Motions, Kinematic Chains, The Denavit-Hartenberg Convention

Module:3	Path and Trajectory Planning	7 hours

The Configuration Space, Path Planning for Q = $\mathbb{R}^2$, Artificial Potential Fields, Sampling-Based Methods, Trajectory Planning

Module:4	Robot assisted minimally invasive surgery	8 hours

Introduction, Minimally invasive surgery and robotic integration, development of surgical robotics systems, Perceptual docking for synergistic control, future scope, Localization and tracking technologies for medical robotics - Requirements for position sensors, Dynamic referencing, Types of position sensors

Module:5	Robotics for neurosurgery and cardiovascular interventions	7 hours

Introduction to neurosurgical progression, Evolution of neurosurgical robots, Maintaining operator Control, Human machine interface, Future trends: informatics surgery Introduction to Heart conditions and evolving role of cardiac surgeons and cardiologists, surgical robot requirements and availability for cardiovascular interventions, Future trends

Module:6	Robotics in Orthopaedic and Knee replacement surgery	5 hours

Introduction, existing orthopedic robotic systems, evaluation of impact of orthopedic surgical robots-Knee replacement surgery, Apex Robotic Technology (ART), Challenges and future scope

Module:7	Robotic surgery and ethical challenges	5 hours

Types of robotic surgery, the patient experience of robotic surgery, the marketing of robotic surgery, comparing robotic surgery with other types of surgery, the need for training, costs versus benefits, ethical issues relating to remotely operated surgery, the automated hospital.

Module:8	**Contemporary Issues**	**2 hours**
Total Hours		**45 hours**
Text Book(s)		
1	Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling and Control", 2nd Edition, Wiley Publisher, 2020.	
2	Paula Gomes, "Medical Robotics: Minimally Invasive Surgery", 1st Edition, Woodhead Publisher, UK, 2012.	
Reference Books		
1	John J. Craig, "Introduction to Robotics, Mechanics and Control", Pearson Education, 3rd Edition, 2010.	
2	Mikell P. Groover, "Industrial Robotics: Technology, Programming and Applications", McGraw-Hill Publishers, 2nd Edition, 2012.	
3	Jaydev P Desai, "The Encyclopedia of Medical Robotics: Vol 1&2", World Scientific, 2018.	
4	JocelyneTroccaz, "Medical Robotics", 1st edition, Wiley, USA, 2013.	
Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.		
Recommended by Board of Studies	07-06-2023	
Approved by Academic Council	No. 70	Date 24-06-2023

Course Code	Course Title	L	T	P	C
MBML612L	Biomedical Laser Instrumentation	3	0	0	3
Prerequisite:	NIL	Syllabus Version			
		1.0			

Course Objectives

1. To provide a comprehensive understanding of Laser basics and medical laser systems.
2. To become familiar with Tissue optics and laser-tissue interactions.
3. To acquire knowledge and insights of Laser applications in medical diagnosis and its therapy.

Course Outcomes

Student is expected:

1. To understand the fundamental and basics of lasers
2. To analyze the different laser systems used in healthcare.
3. To understand the different interactions between laser and human body tissue.
4. To understand and analyze the significance of LASERs in medicine.
5. To acquire knowledge on the various diagnostic applications of laser in healthcare.
6. To identify the various therapeutic applications of lasers in healthcare.

Module:1	LASER basics	4 hours

Laser principle and conditions, setup of laser sources, different types of lasers used in medicine, laser safety aspects, Bottom line basics of lasers.

Module:2	Basics of medical laser systems	5 hours

General setup of medical laser systems, Laser beam guidance systems, Mirror-based and optical fibers, Surgical handpieces and contact tips, Endoscopes, and its types, Operating and surgical microscopes, Bottom line approach of medical laser systems.

Module:3	Tissue optics and laser-tissue interactions 1	6 hours

Optical properties of biological tissue, Modelling the distribution of light in biological tissue, Thermal properties of biological tissue, Interaction of laser irradiation and biological tissue.

Module:4	Tissue optics and laser-tissue interactions 2	6 hours

Photochemical impact on tissue, thermal impact on tissue, Photo-ablation of tissue, Photo-disruption and plasma induced ablation of tissue.

Module:5	Lasers in medical diagnosis	6 hours

Spectroscopic measurement techniques, microscopic measurement techniques – Confocal laser scanning microscopy & stimulated emission depletion microscopy, Optical coherence tomography, Pulse oximetry, Optical capnography, Photoactivation of hematoporphyrin derivative, Flow cytometry, Laser-induced fluorescence for early recognition.

Module:6	Lasers in medical therapy 1	8 hours

Lasers in orthopedics – Intervertebral discs and disc lesions, Percutaneous laser disk decompression, Lasers in urology – Kidney stones and nephrolithiasis, Laser induced shock wave lithotripsy, Lasers in cardiology – Excimer laser assisted non-occlusive anastomosis.

Module:7	Lasers in medical therapy 2	8 hours

Lasers in ophthalmology – Classical laser-assisted *in situ* keratomileusis, Femto-laser assisted *in situ* keratomileusis, Laser treatment of retinal vascular disorders, Lasers in dermatology – treatment of varicose veins, removal of tattoos, Lasers in surgery – cutting of bones and cutting of tissues.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Hours	**45 hours**
Text Book(s)		
1	Stephan Wieneke, and Christoph Gerhard., "Laser in medical diagnosis and therapy – Basics, applications and future aspects", IOP Publishing, Bristol, UK, 2018.	
Reference Books		
1	Frank Träger (Ed.)., "Springer Handbook of Laser and Optics", Springer, 2017.	
2	Karl F Renk., "Basics of Laser Physics"., Springer, 2nd edition, 2018.	
3	Orazio Svelto., "Principles of Lasers", Springer., 5th edition, 2016	
4	Dieter Meschede, "Optics, Light, and Lasers: The Practical Approach to Modern Aspects of Photonics and Laser Physics", Wiley, 2017.	
Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects,Hackathon/Makeathon and FAT.		
Recommended by Board of Studies	07-06-2023	
Approved by Academic Council	No. 70	Date 24-06-2023

Course Code	Course Title	L	T	P	C
MEDS501L	Embedded System Design	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course aimed at

1. Ability to understand comprehensively the technologies and techniques underlying in building an embedded solution to a wearable, mobile and portable system.
2. Analyze UML diagrams and advanced Modelling schemes for different use cases.
3. Understand the building process of embedded systems

Course Outcome

The students will be able to

1. Define an embedded system and compare with general purpose system.
2. Appreciate the methods adapted for the development of a typical embedded system.
3. Get introduced to RTOS and related mechanisms.
4. Classify types of processors and memory architecture
5. Differentiate the features of components and networks in embedded systems
6. Develop real-time working prototypes of different small-scale and medium-scale embedded Systems.
7. Apprehend the various concepts in Multi-Tasking

Module:1	**Introduction to Embedded System**	**5 hours**
Embedded system processor, hardware unit, software embedded into a system, Example of an embedded system, Embedded Design life cycle, Layers of Embedded Systems.		
Module:2	**Embedded System Design Methodologies**	**5 hours**
Embedded System modelling [FSM, SysML, MARTE], UML as Design tool, UML notation, Requirement Analysis and Use case Modelling, Design Examples		
Module:3	**Building Process For Embedded Systems**	**4 hours**
Preprocessing, Compiling, Cross Compiling, Linking, Locating, Compiler Driver, Linker Map Files, Linker Scripts and scatter loading, Loading on the target, Embedded File System.		
Module:4	**System design using general purpose processor**	**7 hours**
Microcontroller architectures (RISC, CISC), Embedded Memory, Strategic selection of processor and memory, Memory Devices and their Characteristics, Cache Memory and Various mapping techniques, DMA.		
Module:5	**Component Interfacing & Networks**	**9 hours**
Memory Interfacing, I/O Device Interfacing, Interrupt Controllers, Networks for Embedded systems- USB, PCI,PCI Express, UART, SPI, I2C, CAN, Wireless Applications - Bluetooth, Zigbee,Wi-Fi.,6LoWPAN , Evolution of Internet of things (IoT).		
Module:6	**Operating Systems**	**7 hours**
Introduction to Operating Systems, Basic Features & Functions of an Operating System, Kernel & its Features [polled loop system, interrupt driven system, multi rate system], Processes/Task and its states, Process/Task Control Block, Threads, Scheduler, Dispatcher.		
Module:7	**Multi Tasking**	**6 hours**
Context Switching , Scheduling and various Scheduling algorithms, Inter-process Communication (Shared Memory, Mail Box, Message Queue), Inter Task Synchronization (Semaphore, Mutex), Dead Lock, Priority Inversion (bounded and unbounded), Priority Ceiling Protocol & Priority Inheritance Protocol		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)			
1.	Raj Kamal, “Embedded systems Architecture, Programming and Design”, Tata McGraw- Hill, 2016.		
2.	Wayne Wolf “Computers as components: Principles of Embedded Computing System Design”, The Morgan Kaufmann Series in Computer Architecture and Design, 2013.		
Reference Books			
1.	Lyla B. Das," Embedded Systems an Integrated Approach", Pearson Education, 2013.		
2.	Shibu K V," Introduction to Embedded Systems", McGraw Hill Education(India) Private Limited, 2014		
3.	Sriram V Iyer, Pankaj Gupta " Embedded Real Time Systems Programming", Tata McGraw- Hill, 2012		
4.	Steve Heath, “Embedded Systems Design”, EDN Series, 2013.		
Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MEDS616L	Machine Leaning and Deep Learning	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course is aimed at

1. Understanding about the fundamentals of machine learning and neural networks
2. Enabling the students to acquire knowledge about pattern recognition.
3. Motivating the students to apply deep learning algorithms for solving real life problems.

Course Outcomes

At the end of the course the student will be able to

1. Comprehend the categorization of machine learning algorithms.
2. Understand the types of neural network architectures, activation functions
3. Acquaint with the pattern association using neural networks
4. Explore various terminologies related with pattern recognition
5. Adopt different feature selection and classification techniques
6. Understand the architectures of convolutional neural networks and Comprehend advanced neural network architectures such as RNN, Autoencoders, and GANs.

Module:1	Learning Problems and Algorithms	4 hours

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

Module:2	Neural Network – I	8 hours

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation

Module:3	Neural Network – II	8 hours

Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning

Module:4	Machine Learning: Terminologies	7 hours

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance

Module:5	Machine Learning: Feature Selection and Classification	7 hours

Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

Module:6	Convolutional Neural Networks	5 hours

Feed forward networks, Activation functions, backpropagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

Module:7	**RNNs, Auto encoders and GANs**	**4 hours**
State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Auto encoders: Convolutional Auto encoders, De-noising auto encoders, Variational auto encoders, GANs: The discriminator, generator, DCGANs		
Module:8	**Contemporary Issues**	**2 hours**
Guest Lectures from Industry and, Research and Development Organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2.	Deep Learning, Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
Reference Books	
1.	The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
2.	Understanding Machine Learning. ShaiShalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

Mode of Evaluation: Continuous Assessment, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	07-06-2023		
Approved by Academic Council	No. 70	Date	24-06-2023

Course code	Course Title	L	T	P	C
MFRE501L	Français Fonctionnel	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
2. Achieve proficiency in French culture oriented view point.

Course Outcome

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

1. Remember the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc.
2. Create communicative skill effectively in French language via regular / irregular verbs.
3. Demonstrate comprehension of the spoken / written language in translating simple sentences.
4. Understand and demonstrate the comprehension of some particular new range of unseen written materials.
5. Demonstrate a clear understanding of the French culture through the language studied.

Module:1	**Saluer, Se présenter, Etablir des contacts. Compétences en lecture - consulter un dictionnaire, appliquer des stratégies de lecture, lire pour comprendre.**	**9 hours**

Les nombres cardinaux- Les 7 jours de la semaine-Les 12 mois de l'année- La date-Les saisons-Les Pronoms personnels sujets-Les Pronoms Toniques- La conjugaison des verbes réguliers- er / - ir /-re verbes (Le présent)- La conjugaison des verbes irréguliers- avoir /être / aller / venir / faire /vouloir /pouvoir etc.

Savoir-faire pour: saluer, et se présenter – épeler en français – communiquer en classe – utiliser des stratégies pour comprendre un texte en français.

Module:2	**Présenter quelqu'un, Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.**	**7 hours**

La conjugaison des verbes Pronominaux (s'appeler/ s'amuser/ se promener)- La Négation- L'interrogation avec 'Est-ce que ou sans Est-ce que'- Répondez négativement.

Module:3	**Situer un objet ou un lieu, Poser des questions**	**6 hours**

Les articles (défini/ indéfini)- Les prépositions (à/en/au/aux/sur/dans/avec etc.)- L'article contracté- L'heure- La Nationalité du Pays- Les professions- L'adjectif (La Couleur, l'adjectif possessif, l'adjectif démonstratif, l'adjectif interrogatif (quel/quelle/quels/quelles)- L'interrogation avec Comment/ Combien / Où etc., Pronoms relatifs simples (qui/que/dont/où).

Module:4	**Comprendre et traduire un texte court, Demander et indiquer le chemin.**	**5 hours**

La traduction simple d'un texte/ dialogue :(français-anglais / anglais –français)

Module:5	**Trouver les questions, Répondre aux questions générales en français, Écouter des vidéos (site internet, YouTube) qui aident à améliorer leur prononciation/ vocabulaire et leurs compétences orales**	**6 hours**

L'article Partitif (du/ de la / de l'/ des) -Faites une phrase avec les mots donnés- Mettez les phrases en ordre, masculin/féminin ; singulier/pluriel- Associez les phrases- les adverbes de temps (ensuite/hier/puis….)

Module:6	**Comment écrire un passage - développer des ompétences rédactionnelles. Discussion de groupe (donnez un sujet et demandez aux élèves de partager**	**5 hours**

	leurs idées)	
Décrivez La Famille -La Maison -L'université -Les Loisirs-La Vie quotidienne- La ville natale- Un personnage célèbre		
Module:7	**Comment écrire un dialogue**	**5 hours**
Dialogue a) Réserver un billet de train b) Entre deux amis qui se rencontrent au café c) Parmi les membres de la famille d) Entre le patient et le médecin e) Entre le professeur et l'étudiant(e)		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Adomania 1, Méthode de français, CelineHimber, Corina Brillant, Sophie Erlich. Publisher HACHETTE, February 2016.
2.	Enchanté 1 !, Méthode de français, Rachana Sagar Private Limited, Jan 2017.
Reference Books	
1.	Le français pour vous 1, Méthode de français, VinodSikri, Anna Gabriel Koshy, Prozopublishing, Jan 2019.
2.	Accueil 1, Méthode de français, Rachana Sagar Private Limited, January 2016
3.	Apprenons le français 1 Méthode de français, Mahitha Ranjit & Monica Singh, Jan 2019
Modeof Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test	

Recommended by Board of Studies	19-05-2022		
Approved by Academic Council	No. 66	Date	16-06-2022

Course code	Course Title	L	T	P	C
MGER501L	Deutsch für Anfänger	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Demonstrate competency in reading, writing and speaking in Basic German.
2. Achieve proficiency in German culture oriented view point.
3. Develop basic vocabulary in the technical field.

Course Outcome

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

1. Communicate in German language in their daily life communicative situations.
2. Apply the German language skill in writing corresponding letters, E-Mailsetc.
3. Create the talent of translating passages from English-German and vice versa and to
   frame simple **dialogues** based on given situations.
4. Understand and demonstrate the comprehension of some particular new range of unseen
   written materials.
5. Develop a general understanding of German culture and society.

Module:1	Die erste Begegnung	6 hours

Einleitung, Begrüssungs formen, Länder und Sprachen, Alphabet, Buchstabieren, Personalpronomen, Zahlen (1-100), Telefonnummer und E-Mail Addressenennen W-fragen, Aussagesätze, Nomen – Singular und Plural und Artikel

Lernziel:

Verständnisvon Deutsch, Genus- Artikelwörter

Module:2	Hobbys und Berufe	6 hours

Über Hobbyssprechen, Wochentage, Jahreszeiten, und Monatenennen, Uhrzeitensagen, über Arbeit, Berufe und Arbeitszeitensprechen, Zahlen (Hundertbiseine Million) Aritel (bestimmter, unbestimmter), Plural der Substantive, Konjugation der Verben (regelmässig /unregelmässig), Ja-/Nein- Frage, Imperativmit Sie.

Lernziel :

Sätzeschreiben, überHobbyserzählen, über Berufesprechenusw.

Module:3	Alltag und Familie	7 hours

Über die Familiesprechen, eineWohnungbeschreiben, Tagesablaufschreiben, Mahlzeiten, Lebensmittel, Getränke Possessivpronomen, Negation, Kasus- Akkusativ und Dativ (bestimmter, unbestimmterArtikel), trennnbareverben, Modalverben, Adjektive, Präpositionen

Lernziel :

Sätzemit Modalverben, Verwendung von Artikel, über Familiesprechen, eine Wohnungbeschreiben.

Module:4	Situations gespräche	6 hours

Dialoge:

a) Gespräche mit Familienmitgliedern, am Bahnhof,
b) Gespräche beim Einkaufen, in einem Supermarkt, in einer Buchhandlung
c) Gespräche in einem Hotel/ in einem Restaurant, Treffen im Cáfe, Termin beim Arzt.

Module:5	Korrespondenz	6 hours

Leseverständnis, Mindmapmachen, Korrespondenz- Briefe, Postkarten, E-Mail

Lernziel :

Wortschatzbildung und aktiverSprachgebrauch

Module:6	Aufsatzschreiben	6 hours

Aufsätze :

Meine Universität, Das Essen, mein Freund odermeine Freundin, meine Familie, einFest in Deutschlandusw.

Module:7	Übersetzungen	6 hours

Übersetzungen : (Deutsch – Englisch / Englisch –Deutsch)

Lernziel :

Grammatik – Wortschatz – Übung		
Module:8	**Trainierung den Sprachfähigkeiten**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Netzwerk A1, Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Ernst Klett Sprachen GmbH, Stuttgart, 2017
Reference Books	
1.	Studio d A1 Deutsch als Fremdsprache, Hermann Funk, Christina Kuhn, Silke Demme: Heuber Verlag, Muenchen, 2012.
2.	Lagune ,Hartmut Aufderstrasse, Jutta Müller, Thomas Storz,. Muenchen, 2012
3.	Deutsche SprachlehrefürAusländer, Heinz Griesbach, Dora Schulz, 2011, Berlin
4.	Themen Aktuell 1, Hartmurt Aufderstrasse, Heiko Bock, MechthildGerdes, Jutta Müller und Helmut Müller, 2010, Muenchen.
	www.goethe.de wirtschaftsdeutsch.de hueber.de, klett-sprachen.de www.deutschtraning.org

Mode of Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test			
Recommended by Board of Studies	19-05-2022		
Approved by Academic Council	No.66	Date	16-06-2022

Course Code	Course Title	L	T	P	C
MSTS601L	Advanced Competitive Coding	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the basic concepts of data structures and algorithm.
2. To develop the step by step approach in solving problems with the help programming techniques of data structures.
3. To deploy algorithms in real time applications.

Course Outcomes

At the end of the course the student should be able to

1. Provide a basic understanding of core Java concepts
2. Use linear and non-linear data structures to solve practical problems.
3. Identify Bitwise algorithms for solving real world problems.
4. Illustrate various techniques for searching, sorting and hashing
5. Understand and implement Dynamic Programming.
6. Design new algorithms or modify existing algorithms for new application.

Module:1	Algorithms	6 hours

Java Introduction, Features, Structure, Data Types, Basic I/O Operators, Decision making and Control structure, Time & Space complexity

Module:2	Math based problems and Bitwise algorithms	6 hours

Simple Sieve, Segmented & Incremental Sieve, Euler's phi Algorithm, Strobogrammatic Number, Remainder Theorem, Toggle the switch & Alice Apple tree, Binary Palindrome, Booth's Algorithm, Euclid's Algorithm, Karatsuba Algorithm, Longest Sequence of 1 after flipping a bit Swap two nibbles in a byte.

Module:3	Arrays , Searching, Sorting and Strings	6 hours

Block Swap Algorithm , Max product subarray, Maximum sum of hour glass in matrix ,Max Equilibrium Sum ,Leaders in array, Majority element, Lexicographically first palindromic string, Natural Sort order , Weightes substring ,Move hyphen to beginning, Manacher's Algorithm

Module:4	Recursion, Back tracking, Greedy Algorithm	6 hours

Sorted Unique Permutation, Maneuvering, Combination, Josephus trap, Maze Solving, N Queens Problem, Warnsdorff's Algorithm, Hamiltonian Cycle, Kruskal's Algorithm ,Activity Selection Problem, Graph Coloring, Huffman Coding

Module:5	Dynamic Programming	6 hours

Longest Common Subsequence ,Longest Increasing Subsequence , Longest Bitonic Subsequence ,Longest Palindromic Subsequence ,Subset sum problem ,0-1 Knapsack, Traveling Salesman, Coin Change, Shortest Common, Supersequence, Levenshtein Distance problem, Rod Cutting problem, Wildcard pattern matching , Pots of gold game

Module:6	Linked list, Stack, Queue	6 hours

Loop Detection, Sort the bitonic DLL, Segregate even & odd nodes in a LL , Merge sort for DLL ,Minimum Stack, The Celebrity problem, Iterative Tower of Hanoi Stock

Span problem, Priority Queue using DLL, Sort without extra Space, Max Sliding Window, Stack permutations		
Module:7	**Trees, Graphs , Heaps, Maps**	**6 hours**
Recover the BST, Views of tree Vertical order traversal ,Boundary traversal, BFS, DFS, Dial's Algorithm ,Bellman-Ford Algorithm, Topological Sort ,Heap Sort Binomial heap, K-array heap, Winner tree, Hash Map to Tree Map.		
Module:8	**Interview Preparation**	**3 hours**
Networking, Security, Operating Systems, Data Base Management Systems.		
Total Lecture hours		**45 hours**

Text Book	
1.	Mark Allen Weiss, “Data structures and algorithm analysis in C++”, 2019, 4th Edition, Pearson Education.
Reference Books	
1.	J.P. Tremblay and P.G. Sorenson, “An Introduction to Data Structures with applications”, 2017, Second Edition, Tata Mc Graw Hill.
2.	Richard M. Reese, Jennifer L. Reese, Alexey Grigorev, Java: Data Science Made Easy, 2019 Pocket Publishing.
Mode of Evaluation: CAT, Written assignment, Quiz, Project & FAT.	

Recommended by Board of Studies	24-02-2023		
Approved by Academic Council	No. 69	Date	16-03-2023

Course Code	Course Title	L	T	P	C
MBML696J	**Study Oriented Project**				**02**
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. The student will be able to analyse and interpret published literature for information pertaining to niche areas.
2. Scrutinize technical literature and arrive at conclusions.
3. Use insight and creativity for a better understanding of the domain of interest.

Course Outcome:

1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains.
2. Examine technical literature, resolve ambiguity, and develop conclusions.
3. Synthesize knowledge and use insight and creativity to better understand the domain of interest.
4. Publish the findings in the peer reviewed journals / National / International Conferences.

Module Content	**(Project duration: One semester)**
This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.	

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML697J	**Design Project**				**02**
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to design a prototype or process or experiments.
2. Describe and demonstrate the techniques and skills necessary for the project.
3. Acquire knowledge and better understanding of design systems.

Course Outcome:

1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model or process or experiments.
2. Utilize the techniques, skills, and modern tools necessary for the project.
3. Synthesize knowledge and use insight and creativity to better understand and improve design systems.
4. Publish the findings in the peer reviewed journals / National / International Conferences.

Module Content	**(Project duration: One semester)**

Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML698J	**Internship I/ Dissertation I**				**10**
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.

Course Outcome:

1. Considerably more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work.
2. The capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.
3. A consciousness of the ethical aspects of research and development work.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Module Content **(Project duration: one semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MBML699J	**Internship II/ Dissertation II**				**12**
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcome:

Upon successful completion of this course students will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing.
5. Synthesize the results and arrive at scientific conclusions / products / solution.
6. Document the results in the form of technical report / presentation.

Module Content **(Project duration: one semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course code	Course Title	L	T	P	C
MENG501P	Technical Report Writing	0	0	4	2
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives

1.To develop writing skills for preparing technical reports.
2. To analyze and evaluate general and complex technical information.
3. To enable proficiency in drafting and presenting reports.

Course Outcome

At the end of the course, the student will be able to
1.Construct error free sentences using appropriate grammar, vocabulary and style.
2. Apply the advanced rules of grammar for proofreading reports.
3. Interpret information and concepts in preparing reports.
4. Demonstrate the structure and function of technical reports.
5. Improve the ability of presenting technical reports.

Indicative Experiments	
1.	**Basics of Technical Communication** General and Technical communication, Process of communication, Levels of communication
2.	**Vocabulary& Editing** Word usage: confusing words, Phrasal verbs Punctuation and Proof reading
3.	**Advanced Grammar** Shifts: Voice, Tense, Person, Number Clarity: Pronoun reference, Misplace and unclear modifiers
4.	**Elements of Technical writing** Developing paragraphs, Eliminating unnecessary words, Avoiding clichés and slang Sentence clarity and combining
5.	**The Art of condensation** Steps to effective precis writing, Paraphrasing and summarizing
6.	**Technical Reports:** Meaning, Objectives, Characteristics and Categories
7.	**Formats of reports and Prewriting**: purpose, audience, sources of information, organizing the material
8.	**Data Visualization** Interpreting Data - Graphs - Tables – Charts - Imagery - Info graphics
9.	**Systematization of Information:** Preparing Questionnaire Techniques to Converge Objective-Oriented data in Diverse Technical Reports
10.	**Research and Analyses:** Writing introduction and literature review, Reference styles, Synchronize Technical Details from Magazines, Articles and e-content
11..	**Structure of Reports** Title – Preface – Acknowledgement - Abstract/Summary – Introduction - Materials and Methods – Results – Discussion - Conclusion - Suggestions/Recommendations
12.	**Writing the Report:** First draft, Revising, Thesis statement, Developing unity and coherence
13.	**Writing scientific abstracts:** Parts of the abstract, Revising the abstract Avoiding Plagiarism, Best practices for writers
14.	**Supplementary Texts** Appendix – Index – Glossary – References – Bibliography - Notes
15	**Presentation**

	Presenting Technical Reports Planning, creating anddigital presentation of reports			
			Total Laboratory hours :	**60 hours**
Text Book(s)				
1.	Raman, Meenakshi and Sangeeta Sharma, (2015).Technical Communication: Principles and Practice, Third edition, Oxford University Press, New Delhi.			
Reference Books				
1.	Aruna, Koneru, (2020). English Language Skills for Engineers. McGraw Hill Education, Noida.			
2.	Rizvi,M. Ashraf (2018)Effective Technical Communication Second Edition. McGraw Hill Education, Chennai.			
3.	Kumar, Sanjay and Pushpalatha, (2018). English Language and Communication Skills for Engineers, Oxford University Press.			
4.	Elizabeth Tebeaux and Sam Dragga, (2020).The Essentials of Technical Communication, Fifth Edition, Oxford University Press.			
Mode of Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test				
Recommended by Board of Studies	19-05-2022			
Approved by Academic Council	No. 66	Date	16-06-2022	

Course Code	Course Title	L	T	P	C
MSTS501P	Qualitative Skills Practice	0	0	3	1.5
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To develop the quantitative ability for solving basic level problems.
2. To improve the verbal and professional communication skills.

Course Outcome:

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

1. Execute appropriate analytical skills.
2. Solve problems pertaining to quantitative and reasoning ability.
3. Learn better vocabulary for workplace communication.
4. Demonstrate appropriate behavior in an organized environment.

Module:1	**Business Etiquette: Social and Cultural Etiquette; Writing Company Blogs; Internal Communications and Planning: Writing press release and meeting notes**	**9 hours**

Value, Manners- Netiquette, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information,. Analysis, Determining, Selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph., Body– Make it relevant to your audience.

Module:2	**Time management skills**	**3 hours**

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, Working under pressure and adhering to deadlines

Module:3	**Presentation skills – Preparing presentation; Organizing materials; Maintaining and preparing visual aids; Dealing with questions**	**7 hours**

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions.

Module:4	**QuantitativeAbility-L1–Numberproperties; Averages; Progressions; Percentages; Ratios**	**11 hours**

Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, increase and Decrease or Successive increase, Types of ratios and proportions.

Module:5	**Reasoning Ability - L1 – Analytical Reasoning**	**8 hours**

Data Arrangement (Linear and circular & Cross Variable Relationship), Blood Relations, Ordering / ranking / grouping, Puzzle test, Selection Decision table.

Module:6	**Verbal Ability -L1 – Vocabulary Building**	**7 hours**

Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies.		
	Total Lecture hours:	**45 hours**
Reference Books		
1.	Kerry Patterson, Joseph Grenny, Ron McMillan and Al Switzler, (2017).2nd Edition, Crucial Conversations: Tools for Talking when Stakesare High .McGraw-Hill Contemporary, Bangalore.	
2.	Dale Carnegie,(2016).How to Win Friends and Influence People. Gallery Books, New York.	
3.	Scott Peck. M, (2003). Road Less Travelled. Bantam Press, New York City.	
4.	SMART, (2018). Place Mentor, 1st edition. Oxford University Press, Chennai.	
5.	FACE, (2016). Aptipedia Aptitude Encyclopedia. Wiley publications, Delhi.	
6.	ETHNUS, (2013). Aptimithra. McGraw – Hill Education Pvt .Ltd, Bangalore.	
Websites:		
1.	**www.chalkstreet.com**	
2.	**www.skillsyouneed.com**	
3.	**www.mindtools.com**	
4.	**www.thebalance.com**	
5.	**www.eguru.ooo**	
Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test		
Recommended by Board of Studies	19-05-2022	
Approved by Academic Council	No.66	Date 16-06-2022

Course Code	Course Title	L	T	P	C
MSTS502P	Quantitative Skills Practice	0	0	3	1.5
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To develop the students' advanced problem solving skills.
2. To enhance critical thinking and innovative skills.

Course Outcome:

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

1. Create positive impression during official conversations and interviews.
2. Demonstrate comprehending skills of various texts.
3. Improve advanced level thinking ability in general aptitude.
4. Develop emotional stability to tackle difficult circumstances.

Module:1	**Resume skills – Resume Template; Use of power verbs; Types of resume; Customizing resume**	**2 hours**

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout-Understanding different company's requirement, Digitizing career portfolio.

Module:2	**Interview skills – Types of interview; Techniques to face remote interviews and Mock Interview**	**3 hours**

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview, Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds.

Module:3	**Emotional Intelligence - L1 – Transactional Analysis; Brain storming; Psychometric Analysis; SWOT analysis**	**12 hours**

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure ,Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways, SWOT analysis.

Module:4	**Quantitative Ability - L3–Permutation - Combinations; Probability; Geometry and menstruation; Trigonometry; Logarithms; Functions; Quadratic Equations; Set Theory**	**14 hours**

Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram.

Module:5	**Reasoning ability - L3 – Logical reasoning; Data Analysis and Interpretation**	**7 hours**

Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data Interpretation-Advanced, Interpretation tables, pie charts & bar chats.		
Module:6	**Verbal Ability - L3 – Comprehension and Critical reasoning**	**7 hours**
Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument.		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Michael Farra and JIST Editors,(2011).Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Jist Works, Saint Paul, Minnesota.
2.	Flage Daniel E, (2003).The Art of Questioning: An Introduction to Critical Thinking. Pearson, London.
3.	David Allen, (2015).Getting Things done: The Art of Stress-Free productivity. Penguin Books, New York City.
4.	SMART, (2018). Place Mentor 1st edition. Oxford University Press, Chennai.
5.	FACE, (2016).Aptipedia Aptitude Encyclopedia. Wileypublications, Delhi.
6.	ETHNUS, (2013).Aptimithra. McGraw-Hill Education Pvt Ltd, Bangalore.

Websites:

1.	www.chalkstreet.com
2.	www.skillsyouneed.com
3.	www.mindtools.com
4.	www.thebalance.com
5.	www.eguru.ooo

Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test			
Recommended by Board of Studies	19-05- 2022		
Approved by Academic Council	No.66	Date	16-06-2022