B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

DEPARTMENT OF MEDICAL ELECTRONICS

SCHEME & SYLLABUS

M.TECH. BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION

I to IV SEMESTER (Academic Year 2018 onwards)

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

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INSTITUTE VISION & MISSION

VISION

Promoting prosperity of mankind by augmenting human resource capital through Quality Technical Education & Training

MISSION

Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society.

DEPARTMENT VISION & MISSION

VISION

To promote quality education in Medical Electronics Engineering for Health and well-being of humankind through teaching and research platforms.

MISSION

- To impart knowledge and skills necessary for professional development of graduates in Medical Electronics Engineering.
- To provide continuous up gradation of technical education with strong academic progression.
- To propagate creativity, responsibility, commitment and leadership qualities and exhibit professional ethics and values.

PROGRAMME OUTCOMES

Program Outcome form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The POs of the PG programme are exemplars of the attributes expected of a graduate of an accredited programme. The POs of the PG programme of the NBA are as following:

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the program.

The mastery should beat a level higher than the requirements in the appropriate bachelor program

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

I Semester

SCHEME

Course Code	Name of the Course	CREDITS			TOTAL CREDITS	CIE	SEE	TOTAL
		L	T	P				
18MLBIPCPE	Physiology for Biomedical Engineers	3	1	0	4	50	50	100
18MLBIPCBA	Biomedical Image Processing and Analysis	3	1	0	4	50	50	100
18MLBIPCBI	Advanced Biomedical Instrumentation	3	0	1	4	50	50	100
18MLBIPEHA	Hospital Administration & Management	3	0	1	4	50	50	100
18MLBIPERS	Real Time Bio Signal Processing							
18MLBIPEES	Electrophysiological Signal Analysis							
18MLBIPEDS	Digital System Design using VERILOG							
18MLBIPEPM	Photonics for medical imaging	3	0	1	4	50	50	100
18ALLPICRM	Research Methodology and IPR	2	0	0	2	50	50	100
TOTAL		17	2	3	22	300	300	600

II Semester **SCHEME**

Course Code	Name of the Course	CREDITS			TOTAL CREDITS	CIE	SEE	TOTAL
		L	T	P				
18MLBIPCMI	Medical Imaging Techniques & systems	3	1	0	4	50	50	100
18MLBIPCBS	Biostatistics	3	0	1	4	50	50	100
18MLBIPCSR	Technical Seminar	0	0	2	2	50	50	100
18MLBIPEML	▪ Machine Learning ▪ Neuroimaging and Brain mapping ▪ Bio nanotechnology ▪ Biosensors and Body area networks ▪ Biomedical applications using FPGA's	3	0	1	4	50	50	100
18MLBIPENB								
18MLBIPEBN		3	0	1	4	50	50	100
18MLBIPEBB								
18MLBIPEFP								
18MLBIOETM	Telemedicine	4	0	0	4	50	50	100
18MLBINC01	Biomaterials	-	-	-	-	-	-	-
TOTAL		16	1	5	22	300	300	600

III Semester **SCHEME**

Course Co	Name of the Course	CREDITS			TOTAL CREDITS	CIE	SEE	TOTAL
		L	T	P				
18MLBIPEES 18MLBIPEPC 18MLBIPEBC	▪ Embedded system design for biomedical applications ▪ Physiological Control Systems and modelling ▪ Brain Computer Interface	3	1	0	4	50	50	100
18MLBIPWP1	Project Phase - I	0	0	10	10	50	50	100
18MLBIPCIN	Internship	0	0	8	8	50	50	100
18MLBINC02	MOOC Course on BMSPI / Allied	--	-	-	--	--	--	--
TOTAL		3	1	18	22	150	150	300

IV Semester **SCHEME**

Course Code	Name of the Course	CREDITS			TOTAL CREDITS	CIE	SEE	TOTAL
		L	T	P				
18MLBIGEIE	Innovation and Entrepreneurship	2	0	0	2	50	50	100
18MLBIPWP2	Project Phase - II	0	0	20	20	50	50	100
TOTAL		2	0	20	22	100	100	200

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

GENERAL GUIDELINES

Regular course (without lab): would be evaluated for 30 Marks as a part of Internal Assessment. Remaining 20 marks would be evaluated using alternative assessment tools. CIE for the theory courses would be 30+20=50 Marks. SEE will be conducted for 100 Marks and reduced to 50 Marks. The final marks would be CIE+SEE (50+50) 100 Marks.

Integrated course (with lab): would be evaluated for 30 Marks as a part of Internal Assessment. Laboratory Work would be evaluated for 20 Marks. All the experiments must be conducted and evaluated. The corresponding Lab reports must be prepared as part of the assessment. Total internal assessment (CIE) would be 30+20=50 Marks. SEE will be conducted for 100 Marks and reduced to 50 Marks. The final marks would be CIE+SEE (50+50) = 100 Marks.

Program Core/Elective with Tutorial: Assessment of additional knowledge would be evaluated for 20 Marks using only alternative assessment tools. Assessment would be part of core or elective course.

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

SEMESTER – I -CORE SUBJECTS

Course Title	PHYSIOLOGY FOR BIOMEDICAL ENGINEERS	Course Code	18MLBIPCBA
Credits	4	L-T-P	3-1-0

CO1 apply basic concepts of physiology for engineering analysis of human physiological systems

CO2 translate the understanding of physiological functions into an engineering model.

CO3 analyze and comprehend the model as an engineering solution.

General Physiology: Cell, Cell junctions, Transport through cell membrane, Homeostasis, Acid base balance.

Respiratory System & Environmental Physiology: Physiological anatomy of respiratory tract, Pulmonary circulation, Mechanics of respiration, Pulmonary function tests, Ventilation, Exchange of respiratory gases, Transport of respiratory gases, Regulation of respiration, Artificial respiration.

Renal Physiology : Kidney, Nephron, Juxtaglomerular apparatus, Renal circulation, Urine formation, Concentration of urine, Acidification of urine, Renal function tests, Renal disorders, Micturition, Uroflow studies, Dialysis.

Cardiovascular System : Introduction to cardiovascular system, Properties of cardiac muscle, Cardiac cycle, Heart sounds, Cardiac murmurs, Electrocardiogram, Vector, Arrhythmia, Cardiac output, Regulation of heart rate, Hemodynamics, Arterial blood pressure, Haemorrhage.

GIS: GIS, Functions of stomach, pancreas, liver, intestine, function tests: endoscopies.
Nervous System-Introduction to nervous system, Neuron, Classification of nerve fibers, Properties of nerve fibers, Degeneration & regeneration of nerve fibers, Neuroglia, Receptors, Synapse, Neurotransmitters, Reflex activity, Physiology of pain,

Hypothalamus, Electroencephalogram Physiology of sleep, Epilepsy, cerebrospinal fluid, Autonomic nervous system and ANS tests. Evoked potentials. Cerebral circulation and tests.

Muscle Physiology: Classification of muscles, Structure of skeletal muscles, Properties of skeletal muscles, Changes during muscular contraction, Neuromuscular junction, Electromyogram & disorders of skeletal muscles Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, joints of hands and fingers, Hip joint, Knee joint, ankle joint, joints of foot and toes.

Physiology of Eye and Ear: Structure of the Eye, Visual process, Field of vision, Visual pathway, Pupillary reflexes, Colour vision, Errors of refraction. ERG and EOG. Structure of ear, Auditory defects.

Text Book:

1. **Essentials of Medical Physiology,** K Sembulingam & Prema Sembulingam (Jaypee Publications, 2004)

Reference Book:

1. **"Concise Medical Physiology"** Sujit K. Chaudhuri, 5thEd, New Central Book Agency

Course Title	BIOMEDICAL IMAGE PROCESSING AND ANALYSIS	Course Code	18MLBIPCBA
Credits	4	L-T-P	3-1-0

CO1: Apply the fundamental concepts of Image processing for Biomedical Image analysis.

CO2: Conduct experiments for medical image enhancement and segmentation.

CO3: Implement open ended experiments for medical image analysis and prepare technical document.

Basics of Medical Image processing- The Nature of Biomedical Images**,** Types of Medical Images Objectives of Biomedical Image Analysis, Computer aided Diagnosis, Fundamental steps in Digital Image Processing, image sensing and acquisition, digital image representation, Basic relationship between pixels, color models.

Image Enhancement- Spatial Domain image enhancement, basic gray level transformations, Histogram equalization, Smoothing spatial filters, Sharpening spatial filters, Image Enhancement in Frequency Domain- Smoothing frequency domain filters, sharpening frequency domain filters, homomorphic filtering, image restoration, a model of restoration process, restoration in presence of noise only, estimating degradation function, inverse filtering.

Detection of region of interest – detection of discontinuities , Thresholding, Otsu's algorithm for optimum thresholding, Detection of Isolated Points and Lines, Edge Detection, Region Growing, Splitting and merging of regions.

Analysis of shape and Texture - chain codes, signatures, boundary segment, skeletons, boundary descriptors, texture, gray level co-occurrence matrix.

Pattern Classification and Diagnostic Decision: Pattern Classification, Supervised Classification, Unsupervised Classification, statistical decision making, Nonparametric decision making, Nearest neighbour classifiers clustering, partitional clustering, neural networks, measures of diagnostic accuracy reliability of features classifiers and decisions.

Text Book:

1. Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, Third Edition. Pearson Education Inc, 2012
2. Earl Gose, Richard Johnsonbaugh, “Pattern Recognition andImage Analysis”, 1st Edition, Prentice Hall of India Privatelimited, 2009.
3. Biomedical Image Analysis, Rangaraj. M Rangayyan, CRC 2015

Reference Books:

1. Image Processing, Analysis and Machine -Vision by Milan Sonka,Vaclav Hlavac & Roger Boyle, Second Edition
2. Biomedical Image Analysis: Segmentation (Paperback)by Scott T. Acton, Nilanjan Ray Published by Morgan Claypool Publishers, United States (2009),ISBN 10: 1598290207
3. Handbook Of Medical Image Processing And Analysis by Isaac Bankman , Academic Press

WEB REFERENCE:

1. http://nptel.iitm.ac.in/courses/106108057

Course Title	ADVANCED BIOMEDICAL INSTRUMENTATION	Course Code	18MLBIPCBI
Credits	4	L-T-P	3-0-1

CO1: Apply the comprehensive knowledge of electronic instrumentation techniques to solve practical problems in the domain.

CO2: Write and present a significant technical report on a medical equipment or its functional element based on literature survey.

CO3: Demonstrate skills to develop solutions based on multidisciplinary approaches for the measurement of Physiological parameters like ECG, EEG, EMG and Pressure.

Measurement Systems: Signals and Noise, static and dynamic characteristics, Determination of Absolute quantity, Medical Instrument design measurement constraints concepts, theory, approach, Requirements and standards.

Physiological Parameters: Extraction of Physiological 1-D parameters, Pressure and Flow, Bio potential recording. Basics of, and Instrumentation for EEG, EMG and ECG.

ECG Case study: Requirements. The patient component and interface method for observation, and features of observation, Noise resolution, safety requirement, EMG performance, Environmental and economic requirements.

Sensors and Electronics: Medical sensor model, conversion principles, circuit protection, function, buffers, interference and instrumentation amplifiers, Instant interference, patient model, ECG model, Analog Filtering, ADC conversion. Case study.

Pressure Measurements: Introduction, Direct Pressure measurement-catheters and diaphragms, Dynamic pressure sensor, Implantable pressure sensor, Indirect measurement of systolic, diabolic and mean blood pressures.

Text Books:

1. Claudio Becchetti and Alessandro Neri, Medical instrument design and development - rom requirements to market placements, Wiley, 1st edition, 2013

2. Steven schreiner, Joseph d. bronzino and Donald R. peterson: Medical instruments and devices principles and practices, CRC press, Taylor & Francis group,1st edition, 2016.

Ref. books:

1. Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg, Biomedical sensors and instruments CRC press, Taylor & Francis group, 2nd edition, 2011
2. John G. Webster, Medical Instrumentation, application and design, Wiley, 3rded, 1998

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

1st Semester PROGRAM ELECTIVES

Course Title	HOSPITAL ADMINISTRATION AND MANAGEMENT	Course Code	18LBIPEHA
Credits	4	L-T-P	3-0-1

CO1: Demonstrate the organizational elements and structure, delivery modalities, barriers to system and process improvement.

CO2: Write and present a significant technical report on creation of policy and processes and ethical considerations inherent in managing healthcare systems and organizations based on literature survey and hospital visits.

Overview of Hospital Administration: Distinction between Hospital and Industry, Challenges in Hospital Administration – Hospital Planning – Equipment Planning – Functional Planning - Current Issues in Hospital Management - Telemedicine - Bio-Medical Waste Management

Human Resource Management in Hospital: Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion –Transfer.

Marketing Research & Consumer Behaviour: Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyerdecision process - Model of business buyer behaviour – Major types of buying situations global marketing in the medical sector - WTO and its implications

Hospital Information Systems & Supportive Services: Management Decisions and Related Information Requirement - Clinical Information Systems – Administrative Information Systems - Support Service Technical Information Systems – Medical

Transcription, Medical Records Department – Central Sterilization and Supply Department– Pharmacy– Food Services - Laundry Services.

Quality And Safety Aspects In Hospital: Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 –9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABA,JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care – Medical Audit – Hazard and Safety in a hospital Setup.

Text Books:-

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006
2. G.D.Kunders, "Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007

Reference Book:

1. Hospital Management: Text & Cases by K. V. Ramani, ISBN: 9788131794012 Imprint:Pearson Education.

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

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Course Title	REAL TIME BIO-SIGNAL PROCESSING	Course Code	18MLBIPERS
Credits	4	L-T-P	3-0-1

CO1. Implement computationally efficient algorithms on the DSP platform for bio signals.

CO2. Analyze real-time filter structures for performance evaluation using modern tools.

CO3. Develop multirate signal processing algorithms for real-time bio signals as case study, and present a technical report on the same.

Real time Signals and Systems: Overview on Continuous and Discrete time signals and Systems. Properties, Fourier analysis of discrete time signals and continuous time signals. Real time Convolutions (linear and circular) Real time correlations. Linear filtering aspects of convolutions. Case studies on 1-D and 2-D implementation.

Real time Digital Filters: Exposition on Filter designs structures. Real-Time FIR Digital Filters. Real-Time IIR Digital Filters, Real time Lattice structures and its implementation issues. Real time Transforms and its Algorithms: Real-Time Fast Fourier Transform (1-D and 2-D cases),

Discrete Cosine Transform (1-D and 2-D cases) Walsh Hadamard Transforms Basics and algorithms.(1-D and 2-D Cases), Haar Transform (1-D & 2-D cases), Basic of Discrete Wavelet Transform (1-D and 2-D Cases).

Multi-rate filters: Basics principles of decimations and interpolation, Noble identities and its advantages. Quadrature mirror Structures and Poly-phase structures, rational Sample Rate converters.

Adaptive Filters: Basics optimum signal processing, Wiener filters adaptive structures. LMS algorithms and simple variations. RLS algorithms, Basic Kalman Filters with implementations. Random processes: Types, Examples, Notion of stationarity and Ergodicity. White noise, filtering random processes, spectral factorization, ARMA, AR and MA Processes.

Text Books:

1. Modern Digital Signal Processing by Roberto Cristi, Cengage Learning, 2004
2. Joseph Yiu, The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors

Reference Book:

1. Digital Signal Processing and Applications with the OMAP - L138 eXperimenter, Wiley

E Books:

1. The Scientist and Engineer's Guide to Digital Signal Processing By Steven W. Smith, Ph.D.

MOOCS:

1.https://www.mooc-list.com/course/applied-digital-signal-processing

2.Sign up at http://www.coursera.org/course/dsp

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	ELECTROPHYSIOLOGICAL SIGNAL ANALYSIS	Course Code	18MLBIPEES
Credits	4	L-T-P	3-0-1

CO1: Apply the knowledge of electrophysiological signals (ECG & EEG) for analysis in medical diagnosis

CO2: Identify the signal characteristics in normal and ailment conditions

CO3: Analyze real world electrophysiological signal using modern tools and prepare research report

Basics of Cardiovascular Signal: The Physiological Basis of the Electrocardiogram: Cellular Processes that Underlie the ECG, The Physical Basis of Electrocardiography, The Normal Electrocardiogram, Introduction to Clinical Electrocardiography, Abnormal Patterns, The Normal Determinants of Heart Rate: The Autonomic Nervous System (Ectopy, Tachycardia, and Fibrillation), Conduction Blocks, Bradycardia, and Escape Rhythms, Cardiac Ischemia, Other Metabolic Disturbances, and Structural Abnormalities, A Basic Approach to ECG Analysis.

ECG Statistics, Noise, Artifacts, and Missing Data: Spectral and Cross-Spectral Analysis of the ECG, Extreme Low and High Frequency ECG, The Spectral Nature of Arrhythmias, Standard Clinical ECG Features, Non-stationarities in the ECG, Heart Rate Hysteresis, Arrhythmias, Arrhythmia Detection, Arrhythmia Classification from Beat Typing, Arrhythmia Classification from Power-Frequency Analysis, Arrhythmia Classification from Beat-to-Beat Statistics, Noise and Artifact in the ECG, Noise and Artifact Sources, Measuring Noise in the ECG, Heart Rate Variability, RR Interval Models, The Cardiovascular System, The DeBoer Model, Integral Pulse Frequency Modulation Model, Nonlinear Deterministic Models, RR Interval Models for Abnormal Rhythms, ECG Models, Pathophysiology Guided T-Wave Alternans Measurement,, ECG-Derived Respiratory Frequency Estimation, ST analysis

Basic of Neural Signal Acquisition and processing: Introduction to EEG signal, Neural Activities, Action Potentials, EEG Generation , Brain Rhythms, EEG Recording and

Measurement, Conventional Electrode Positioning , Conditioning the Signals, Abnormal EEG Patterns, Ageing , Mental Disorders, Dementia , Epileptic Seizure and Non-epileptic Attacks, Psychiatric Disorders. External Effects

Neural Signal Analysis: Fundamentals of EEG Signal Processing , EEG Signal modeling, Linear Models , Nonlinear Modeling, Generating EEG Signals Based on modeling the Neuronal Activities, Nonlinearity of the Medium, Non-stationary, Signal Segmentation, Signal Transforms and Joint Time–Frequency Analysis, Wavelet Transform, Ambiguity Function and the Wigner–Ville Distribution

Event-Related Potentials: Detection, Separation, Localization, and Classification of P300 Signals, Using ICA, Estimating Single Brain Potential Components by modeling ERP Waveforms, Source Tracking, Localization of the ERP, Time–Frequency Domain Analysis, Adaptive Filtering Approach.

Text Books:

1. Advanced Methods and Tools for ECG Data Analysis, Francisco Azuaje, Gari D. Clifford, and Patrick E. McSharry, ISBN-13: 978-1580539661,
2. EEG Signal Processing, Saied Sanei and J A Chambers, John Wiely and Sons Limited, 2007.

Reference Books:

1. Introduction to Electrophysilogical methods and instrumentation, Franclin Bretschneider and Jan R De Weille, ISBN 978-0-12-370588-4.
2. Computer Analysis of Electrophysiological Signals, John Dempster, 2. http://iitr.vlab.co.in/?sub=49&brch=267&sim=1305&cnt=1

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19
(Autonomous College under VTU)

Course Title	DIGITAL SYSTEM DESIGN USING VERILOG	Course Code	18MLBIPEDS
Credits	4	L-T-P	3-0-1

CO1: Design, simulate and synthesize digital circuits with Verilog .

CO2: Evaluation of Digital circuits using EDA tools.

CO3: Optimize the design for different parameters.

Introduction to Verilog: Design Methodology-An Introduction Verilog History, System representation, Number representation and Verilog ports. Verilog Data Types: Net, Register and Constant. Verilog Operators: Logical, Arithmetic, Bitwise, Reduction, Relational, Concatenation and Conditional.Verilog Primitives.Logic Simulation, Design Verification, and Test Methodology:Four-Value Logic and Signal Resolution in Verilog, Test Methodology Signal Generators for Test benches, Event-Driven Simulation, Sized Numbers.Propagation Delay.

Modeling Styles: Dataflow Modeling: Boolean Equation-Based Models of Combinational Logic, Propagation Delay and Continuous Assignments. Structural Modeling: Design of Combinational Logic, Verilog Structural Models, Module Ports, Top-Down Design and Nested Modules. Gate level modeling Behavioral Modeling: Latches and Level-Sensitive Circuits in Verilog, Cyclic Behavioral Models of Flip-Flops and Latches, Cyclic Behavior and Edge Detection. A Comparison of Styles for Behavioral modeling, Behavioral Models of Multiplexers, Encoders, and Decoders.Dataflow Models of a Linear-Feedback Shift Register. Modeling Digital Machines with Repetitive Algorithms Machines with Multicycle Operations. Tasks & Functions.

Algorithmic State Machine Charts for Behavioral Modeling:Algorithmic State Machine Charts for Behavioral Modeling, ASMD charts, Behavioral Models of Counters, Shift Registers, and Register Files and Arrays of Registers (Memories). Design Example: Keypad Scanner and Encoder. Synthesis of Combinational Logic: Introduction to Synthesis, Synthesis of Combinational Logic, Synthesis of Sequential Logic with Latches, Synthesis of Three-state Devices and Bus Interfaces

Synthesis of Sequential Logic: Synthesis of Sequential Logic with Flip-Flops, Synthesis of Explicit State Machines, Registered Logic, State Encoding, Synthesis of Implicit State Machines, Registers and Counters, Implicit State Machines, Resets, Synthesis of Gated Clocks and Clock Enables.

Implementation Fabrics: Introduction of Programmable Logic Array (PLA), Programmable Array Logic (PAL), Programmability of PLDs.Complex PLDs (CPLDs), Field-Programmable

Gate Arrays .The Role of FPGAs in the ASIC Market, FPGA Technologies. Verilog-Based Design Flows for FPGAs and ASICs. Comparison of design implementation using CPLDs, FPGA and ASIC

Design of Processor Architectures for Arithmetic Processors: Number Representation: Signed Magnitude Representation of Negative Integers, Ones Complement Representation of Negative Integers, Twos Complement Representation of Positive and Negative Integers, Representation of Fractions. Functional Units for Addition and Subtraction: Ripple-Carry Adder, Carry Look-Ahead Adder, Overflow and Underflow. Functional Units for Multiplication: Combinational (Parallel) Binary Multiplier, Sequential Binary Multiplier, Sequential Multiplier Design: Hierarchical Decomposition STG-Based Controller Design, Efficient STG-Based Sequential Binary Multiplier.

Text Book:

1. M.D. Ciletti Advanced Digital Design with the Verilog HDL Published by Prentice Hall PTR -2nd Editions ISBN: 0136019285.

Reference Books:

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design & Synthesis", SunSoft Press, 1st Edition, 1996, ISBN: 978-81-775-8918-4.
2. Roth, Charles; John, Lizy K.; Kil Lee, Byeong Digital Systems Design Using Verilog ISBN 10: 1285051076 / ISBN 13: 9781285051079.
3. J Bhaskar , "Verilog Primer", Pearson / PHI, New Delhi, 3rd Edition, 2003

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19
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Course Title	PHOTONICS FOR MEDICAL IMAGING	Course Code	18MLBIPEPM
Credits	4	L-T-P	3-0-1

CO1: Analyze the laser principles with safety regulations, optical set up design for biomedical applications.

CO2: Utilize optical components for microscopes in biomedical imaging with simulation research studies with a research analysis report.

CO3: Understand the optical biosensor for image transduction and case study analysis.

Basic of Lasers: Principles of Lasers, Current Laser Technology, and Nonlinear Optics: Principles of Lasers, Principles of Laser Action, Classification of Lasers, Some Important Lasers for Bio-photonics Current Laser Technologies, Quantitative Description of Light: Radiometry, Nonlinear Optical Processes with Intense Laser Beam, Mechanism of Nonlinear Optical Processes, Frequency Conversion by a Second-Order Nonlinear Optical Process, Symmetry Requirement for a Second-Order Process, Frequency Conversion by a Third-Order, Nonlinear Optical Process, Multiphoton Absorption, Time-Resolved Studies, Laser Safety.

Bio-imaging: Principles and Techniques: An Overview of Optical Imaging, Transmission Microscopy, Simple Microscope, Compound Microscope, Kohler Illumination, Numerical Aperture and Resolution.

Optical Bio-microscopic Imaging: Optical Aberrations and Different Types of Objectives, Phase Contrast Microscopy, Dark-Field Microscopy, Differential Interference Contrast Microscopy, Fluorescence Microscopy, Scanning Microscopy, Confocal Microscopy, Multi-photon Microscopy. Optical Coherence Tomography, Total Internal Reflection Fluorescence Microscopy, Near-Field Optical Microscopy, Spectral and Time Resolved Imaging, Spectral Imaging , Band pass Filters, Excitation Wavelength Selection, Acousto-Optic Tunable Filters, Localized Spectroscopy, Fluorescence Resonance Energy Transfer (FRET) Imaging, Fluorescence Lifetime Imaging Microscopy (FLIM), Nonlinear Optical Imaging, Second-Harmonic Microscopy, Third-Harmonic Microscopy, Coherent , Anti-Stokes Raman Scattering (CARS) Microscopy, Multifunctional Imaging, Pi Imaging, Combination Microscopes, Miniaturized Microscopes, Some Commercial Sources of Imaging Instruments,

Applications of Bio-photonics: Fluorophores as Bio-imaging Probes, Organometallic Complex Fluorophores, Near-IR and IR Fluorophore, Two-Photon Fluorophores, Inorganic Nanoparticles, Green Fluorescent Protein, Imaging of Organelles, Imaging of Microbes, Confocal Microscopy, Near-Field Imaging, Cellular Imaging, Probing Cellular Ionic Environment, Intracellular pH Measurements, Optical Tracking of Drug-Cell Interactions, Imaging of Nucleic Acids, Cellular Interactions Probed by

FRET/FLIM Imaging, Tissue Imaging, In Vivo Imaging, Commercially Available Optical Imaging Accessories,

Optical Biosensors: Principles of Optical Bio-sensing, Bio-recognition, Optical Transduction, Fluorescence Sensing, Fluorescence Energy Transfer Sensors, Molecular Beacons, Optical Geometries of Bio-sensing, Support for and Immobilization of Bio-recognition Elements. Immobilization, Planar Waveguide Biosensors, Evanescent Wave Biosensors, Interferometry Biosensors, Surface Plasmon Resonance Biosensors, Some Recent Novel Sensing Methods, Commercially available sensors.

Text Book:

1. Introduction to Bio-photonics, Paras N Prasad, A John Wiley & Sons, Inc., Publication. 2003. Reference Book: Biomedical Optics: Principles and Imaging, Lihong V Wang, Hsin-I Wu, ISBN: 978-0- 471-74304-0, May 2007. 3

Reference Book:

1. Fundamentals of Light Microscopy and Electronic Imaging, Douglas B Murphy, John Wiely & Sons, 2001, ISBN-0-471-25391-X

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19
(Autonomous College under VTU)

Course Title	RESEARCH METHODOLOGY AND IPR	Course Code	18ALLPICRM
Credits	2	L-T-P	2-0-0

Module 1:
Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

Module 2:
Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - Reviews, treatise, monographs patents - web as a source - searching the web - Identifying gap areas from literature review - Development of working hypothesis.

Module 3:
IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs- Integrated Circuits-Geographical Indications-Establishment of WIPO-Application and Procedures.

Module 4:
Aim of this part of the course: is to strengthen students minds towards high quality research through publications, patents and also to learn research ethics. Publications (8-9 hours) Research concepts (2 hour) Research importance on economy, Research in India and abroad, Importance of publications, Why, where, when to publish? Publication ethics (2 hour), Plagiarism (how to use Turnitin effectively), International ethics on research, What and what not to publish, Ethical guidelines, Case studies
Quality vs quantity (2 hour) Searching literature with high quality, Impact factor, Citations (google scholar vs web of science), H-index, Case studies, How to write paper (2 hour),

In High quality journals, Conference Articles, Poster preparation, PhD thesis, Inclusion of References, Journal reviewing process (1 hour), Selection of the good journal, Knowledge bout journal template, Refereeing process, Research topic selection, Research today and tomorrow, Lab scale to Industry, Traditional research to Technology based research

Module 5: Self study

Interpretation and report writing - Techniques of interpretation - Structure and components of scientific reports - Different steps in the preparation - Layout, structure and language of the report - Illustrations and tables - Types of report - Technical reports and thesis

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
9. Intellectual Property Rights in the Global Economy: Keith Eugene Maskus, Institute for International Economics, Washington, DC, 2000
10. Subbarau NR-Handbook on Intellectual Property Law and Practice-S Viswanathan Printers and Publishing Private Limited.1998

Course Title	MEDICAL IMAGING TECHNIQUES AND SYSTEMS	Course Code	18MLBIPCMI
Credits	4	L-T-P	2-0-0

CO1 Think laterally and originally, conceptualize and solve engineering problems,
identify potential issues in an imaging system considering public health and safety.

CO2 apply the appropriate techniques to transform images for better visualization and interpretation.

CO3 Extract information pertinent to unfamiliar problems through literature survey,
apply appropriate research methodologies to design ,analyse and interpret data,
Demonstrate higher order skill and view things in a broader perspective.

Introduction to Diagnostic Imaging Modalities: Basic Imaging Principles, Overview of the different modalities of diagnostic imaging, Axial, Coronal and Sagittal Views, Introduction to DICOM, Introduction to Image Viewing Software.

X-rays: Historical Overview, Fundamentals of X-rays, Electromagnetic Radiation, Interaction of X-rays with Matter, Intensity of an X-ray Beam, Attenuation and Factors affecting Attenuation, Generation of X-ray Radiation, X-Ray Generators, Filters, Beam Restrictors and Grids, X-ray Imaging Geometry, Film Radiography, Intensifying Screens and Image Intensifiers, Computed Radiography, Digital X-ray Detectors, X-ray Image Characteristics, Spatial Resolution, Noise and Contrast, Biological Effects of Ionizing Radiation, Units of Dose, Precautionary Measures while using X-rays, Fluoroscopy, Angiography, Digital Subtraction Angiography, Orthopantomography, Dual Energy X-ray Absorptiometry, Linear Accelerators,

Computed Tomography: Historical Overview, Conventional Tomography, Fundamentals of Computed Tomography, Generations of CT Machines from First to Seventh, Projection Function, Houns field Unit, Forward and Inverse Problems, Radon Transform, Sinogram, Algorithms for Image Reconstruction, Back Projection, Filtered Back Projection, Fourier Transform Methods, Fourier Slice Theorem, Algebraic Reconstruction Techniques, Parallel Beam Reconstruction, Fan Beam Reconstruction, Cone Beam Reconstruction, Helical CT, Maximum Intensity Projection Reconstruction, Volume Rendering, Artifacts in CT Images, Some Clinical Applications.

Ultrasound: Historical Overview, Fundamentals of Acoustic Propagation, Stress and Strain Relationships, Characteristic Impedance, Intensity, Radiation Force, Reflection, Refraction, Attenuation, Absorption, Scattering, Doppler Effect, Generation and Detection of Ultrasound, Piezoelectric Effect, Ultrasonic Transducers, Transducer Beam Characteristics, Beam Profiles,

Pulsed Ultrasound, Phased Arrays, Resolution – Axial and Lateral, Focussing of Ultrasound, Diagnostic Methods, Pulse Echo Systems, A-mode, B-mode, M-mode, C-mode, Ultrasound Image Characterization, Tissue Characterization, Colour Doppler Flow Imaging, Echocardiography, Biological Effects of Ultrasound, Ultrasound Safety, 3D Ultrasound, High Intensity Focussed Ultrasound (HIFU), Some Clinical Applications.

Nuclear Medicine: Historical Overview, Fundamentals of Radioactivity, Nuclear Activity and its Units, Half Life, Interaction of Nuclear Particles and Matter, Attenuation of Gamma Radiation, Radionuclides, Radiopharmaceuticals, Common Radioisotopes, Generation and Detection of Nuclear Emission, Radionuclide Generators, Cyclotrons, Nuclear Radiation Detectors, Rectilinear Scanners, Scintillation Camera, Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET), PET-CT and PET-MR Systems, PET Image Reconstruction, Attenuation Correction, Characteristics of Images, Contrast and Noise, Nuclear Radiation Safety, Some Clinical Applications.

Magnetic Resonance Imaging: Historical Overview, Fundamentals of Nuclear Magnetic Resonance, Angular Momentum, Dipole Moment, Magnetization, Larmor Frequency, Rotating Frame of Reference, RF Magnetic Field, Free Induction Decay, Relaxation Times, Pulse Sequences, Generation and Detection of NMR Signal, Main Magnetic Field, Gradient Magnetic Fields, Superconducting Magnets, Transmitter, Receiver, Slice Selection, Frequency Encoding, Phase Encoding, Spin-Echo Imaging, Gradient-Echo Imaging, Biological Effects of Magnetic Fields, Imaging Safety, Introduction to Functional MRI, Diffusion Weighted Imaging, Introduction to Image Registration in Multi-modal imaging, Some Clinical Applications

Text Book:

1. Kirk Shung, Michael Smith, Benjamin Tsui, Principles of Medical Imaging,Academic Press, 1992.
2. Khandpur

Reference Books:

1. Jerry Prince, Jonathan Links, Medical Imaging Signals and Systems, Pearson, 2008
2. edX MOOC Course, Principles of Biomedical Imaging, online course.
3. Internet Text References and Videos.

Course Title	BIOSTATISTICS	Course Code	18MLBIPCBS
Credits	4	L-T-P	3-0-1

CO1: ability to apply concepts in biostatistics to solve problems in the domain.

CO2: Demonstrate skills to to perform statistical tests using suitable tools and interpret results

CO3: implement open ended experiment for statistical analysis and prepare technical document on it.

Introduction to Biostatistics: Introduction, Some basic concepts, Descriptive Statistics: measure of central tendency, measure of dispersion, basic probability concept Baye's theorem

Probability distributions- binomial distribution, Poisson distribution, continuous probability distribution, normal distribution, sampling distributions: distribution of sample mean, distribution of the difference between two sample means, distribution of sample proportion, distribution of the difference between two sample proportions

Estimation: confidence interval for a population mean, t-distribution, confidence interval for differences between two population means, confidence interval for a population proportion, confidence interval for difference between two populations determination of sample size for estimating means, for estimating proportions , confidence interval for the variance of normally distributed population, Chi square distribution, confidence interval for ratio of variances of two normally distributed populations

Hypothesis Testing : Introduction, hypothesis testing – single population mean, difference between two population means, paired comparisons, hypothesis testing-single population proportion, difference between two population proportions, single population variance, ratio of two population variances.

Analysis of Variance (ANOVA): Introduction, one way ANOVA, two way ANOVA Linear Regression and Correlation: the regression model, sample regression equation, evaluating and using regression equation, correlation model, correlation coefficient

TEXT BOOKS:

1. "Biostatistics-A Foundation for Analysis in the Health Sciences" Wayne W. Daniel, John Wiley & Sons Publication, 6th Edition
2. Fundamentals of Biiostatistics by khan and khanum, Ukaaz publications, 2nd revise edition
3. "An introduction to statistical Method and data analysis", by R. Lyman ott

REFERENCE BOOKS

1. "Principles of Biostatistics", Marcello Pagano and Kimberlee Gauvreu, Thomson Learning Publication, 2006.
1. "Introduction to Biostatistics" by Ronald N Forthofer and EunSul Lee, Academic Press
2. "Basic Biostatistics and its Applications" Animesh K. Dutta (2006)

E-book:

1. http://ebookee.org/Biostatistics-A-Methodology-For-the-Health-Sciences_

Online course

1. ocw.mit.edu › Courses › Mathematics › Linear Algebra
2. www.extension.harvard.edu › Open Learning Initiative
3. mathematical-biostatistics-boot-camp-2-coursera

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19
(Autonomous College under VTU)

2nd Semester PROGRAM ELECTIVES

Course Title	MACHINE LEARNING	Course Code	18MLBIPEML
Credits	4	L-T-P	3-0-1

Course Outcomes:

CO1: Apply the knowledge of learning problems and models used in machine learning.

CO2: Identify and analyze the learning models to interpret the data.

CO3: Design , implement and demonstrate an open ended experiment for biomedical data using modern tool.

Introduction: Learning Problems, Designing Learning systems, Perspectives and Issues. Concept learning: Concept Learning, Version Spaces and Candidate Elimination Algorithm, Inductive bias. Decision Trees**:** Decision Tree learning, Representation, Algorithm, Heuristic Space Search.

Regression: Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM Clustering: k-means, Adaptive hierarchical clustering, Gaussian mixture model.

Neural Networks: Neural Network Representation, Problems, Perceptron, Multilayer Networks and Back Propagation Algorithms. Genetic Algorithms: Hypothesis Space Search, Genetic Programming, Models of Evolution and Learning.

Bayesian Learning: Bayes Theorem, Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, EM Algorithm.

Instant Based Learning: K-Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Sequential Covering Algorithm. **Learning set of rules:** Learning Rule Sets, Learning First Order Rules, Learning Sets of First Order Rules, Induction as Inverted Deduction, Inverting Resolution.

TEXT BOOKS:

1. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (INDIAN EDITION), 2013.
2. Ethem Alpaydin, “Introduction to Machine Learning”, 2nd Ed., PHI Learning Pvt. Ltd., 2013.

REFERENCE BOOKS:

1. T. Hastie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer; 1st edition, 2001.

ONLINE COURSE LINKS:

1. https://www.coursera.org/learn/machine-learning.
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-867-machine-learning-fall-2006/syllabus/#Calendar.
3. https://onlinecourses.nptel.ac.in/noc18_cs40/

E-BOOK:

1. Andreas C. Müller & Sarah Guido, Introduction to Machine learning with Python- A Guide for Data Scientists, Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

2. Ethem Alpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	NEUROIMAGING AND BRAIN MAPPING	Course Code	18MLBIPENB
Credits	4	L-T-P	3-0-1

CO1: Have a neuroanatomical knowledge, in-depth knowledge of the technological bases of each neuroimaging technique and have a good knowledge of the relative advantages and disadvantages of each technique, based on their strengths and limitations. (PO3-2,PO1-1)

CO2: have comprehensive understanding of each stage of pre-processing neuroimaging data , image analysis and able to draw appropriate inferences based on the image analysis employed. (PO3-2,PO1-1)

CO3: will learn how to conduct various aspects of image analysis through hands-on experience with analyses packages and execute a open ended project, present and document the same. (PO3-2,PO2-2,PO1-1)

Introduction to Neuroimaging and Brain Mapping Terminology: Review of Neuroanatomy. The Physics of Neuroimaging (invasive and non-invasive, structural vs. functional, digital data representation).The Normal Brain, The Developing Brain, Matured Brain, Aging Brain Diseases: Depression, Schizophrenia, Autism, Bipolar disorder, Neurodegeneration and dementia(AD), Epilepsy, Multiple Sclerosis, Methamphetamine, Foetal Alcohol Syndrome, Head Trauma, Tumours.

Neuroimaging Techniques: Functional and structural neuroimaging methodology of neuroimaging techniques of MRI, fMRI, PET and EEG/ERP, highlighting their relative strengths and limitations.

Image processing and Analysis : Pre-processing of neuroimaging data , Diffusion Weighted Imaging, Image Segmentation and Registration, Image Smoothing and MARM. Functional Data Analysis. Low-rank Representation.

Data Analysis: Analysis of neuroimaging data using varied designs, such as blocked, event-related and mixed designs. Image analysis through hands-on experience with analyses packages. Prediction Models. Imaging Genetics. Big Data Integration. statistics on neuroimaging data.

Cognitive Psychology for Clinical Neuroscience: Introduction to cognitive psychology , theoretical developments in a wide selection of areas of cognition, cognitive models ,examples of computational models, role played by behavioural experiments in establishing and testing models of cognition. Neuroimaging applications in : language, memory, attention, face recognition, cross-modal processing, sleep, emotion and social cognition, neural bases of cognition, emotion, social cognition and behaviour.

BOOK:

1. Handbook of Functional Neuroimaging of Cognition, 2nd edition. Edited by Roberto Cabeza and Alan Kingstone.
2. Statistical Parametric Mapping: The Analysis of Functional Brain Images
3. edited by William D. Penny, Karl J. Friston, John T. Ashburner, Stefan J. Kiebel, Thomas E. Nichols
4. Neuroradiology: The Requisites (Requisites in Radiology) 4th Edition
5. by Rohini Nadgir MD (Author), David M. Yousem MD MBA (Author)

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B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	BIO NANOTECHNOLOGY	Course Code	18MLBIPEBN
Credits	4	L-T-P	3-0-1

CO1 Understand the essential features of biology and nanotechnology that are converging to create the new area of bio-nanotechnology.

CO2 Recognize the structural and functional principles of bio-nanotechnology

CO3 Employ bio-nanomaterials for biomedical sensing applications

NANOBIOMATERIALS AND BIOCOMPATIBILITY: Surface and Bulk Properties of Bio materials – Nanobiomaterials –NanoCeramics – Nanopolymers – Nano Silica – Hydroxy apatite - Carbon Based nanomaterials -Surface modification – Textured and Porous Materials – Surface immobilized biomolecules – Cell-biomaterial interactions – immune response – In Vitro and In Vivo assessment of tissue compatibility

STRUCTURAL & FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY: Lipid Bilayers – liposomes – neosomes- Polysacharides - Peptides –Nucleic acids – DNA scaffolds – Enzymes- Biomolecular motors: linear, rotary motors – Immunotoxins – Membrane transporters and pumps – Antibodies – monoclonal Antibodies – immunoconjugates - limitations of natural biomolecules

PROTEIN AND DNA BASED NANOSTRUCTURES: Nanocircuitry - S-layer proteins: structure, chemistry and assembly – lipid chips –S - Layers as Templates – engineered nanopores - DNA–Protein Nanostructures - DNA-templated Electronics - DNA-based Metallic Nanowires and Networks - DNA–Gold-Nanoparticle Conjugates – DNA -templated Electronics – DNA Nanostructures for Mechanics and Computing.

NANOBIO-ANALYTICS: Luminescent Quantum Dots for Biological Labeling - Nanoparticle Molecular Labels - Surface Biology: Analysis of Biomolecular Structure by Atomic Force Microscopy and Molecular Pulling - Force Spectroscopy – Bio-functionalized Nanoparticles for Surface - Enhanced Raman Scattering and Surface Plasmon Resonance – Bio-conjugated Silica Nanoparticles for Bioanalytical Applications.

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(Autonomous College under VTU)

NANOTECHNOLOGY IN FOOD, MEDICINE AND HEALTH SCIENCE: Nano particle Based Drug delivery systems - Ultra sound triggered Nano/Micro bubbles - Regenerative Medicine – Nano-immuno conjugates- Biosensors - Optical Biosensors Based on Nano-plasmonics – Nano-biosesors - Nano-Biosensors for Mimicking Gustatory and Olfactory Senses -Cyclodextr in in Nano-medicinal Foods and Cosmetics - Bioavailability and Delivery of Nutraceuticals and Functional Foods Using Nanotechnology – Polymer Based Nano-composites for Food Packaging – Nano-composites for Food Packaging - Toxicity and Environmental Risks of Nano-materials

Text Book:

1. Niemeyer C. M., "Nano-biotechnology: Concepts, Applications and Perspectives", Wiley – VCH, 2006.

Reference Books:

1. David S Goodsell, "Bio-nanotechnology", John Wiley & Sons, 2004.

2. Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi, "BioNanotechnology: A Revolution in Food, Biomedical and Health Sciences" Wiley Blackwell, 2013.

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	BIOSENSORS AND BODY AREA NETWORKS	Course Code	18MLBIPEBB
Credits	4	L-T-P	3-0-1

CO1 Apply the fundamental concepts to differentiate and interpret the data related to performance characteristics of biosensors.

CO2 Select, learn and deploy suitable sensors for a wide range of potential problems related to health monitoring domain for the analytes – Glucose, Cholesterol, nitrite, nitrate and urea

CO3 Work in multidisciplinary teams consisting of biologists, doctors, pathologists and electronic communication engineers to analyze and understand issues related to wireless biosensor networks.

Introduction to Biosensors: Components, Classification, Generations of biosensors, Molecular recognition, Biosensor electrode fabrication, Applications of biosensors.

Amperometric Biosensor Based on Carbon Nanotube and Plasma Polymers: Introduction, Plasma polymerization for biosensor design, Optimization, for device fabrication, comparison between single- and multi-walled CNT, mechanism of sensor response, sensor performance.

Enzymatic and Immunosensors: History, Biomarkers, Glucose sensors, Cholestrol biosensors, Nitrite and nitrate sensors. Antibody as biorecognition element, Types of immunosensors.

Urea Biosensor based on Conducting Polymer Transducers: Various electrochemical techniques, Comparison, Effect of enzyme loading on urea biosensor response, Stability of the urea biosensor: Estimation of urea in biological sample.

Intelligent Communication Module for Wireless Biosensor Networks: Wireless biosensor networks- Introduction and applications, Ultra wideband radio as a communication module for WBSN, UWB Transmitter & Receiver, Real time reconfigurability algorithm, RTRA design and implementation, Translation And Control Algorithms.

Text ooks

1. Biosensors and Bioelectronics: Chandran Karunakaran, Kalpana Bhargava, Bosson Benjamin, Elsevier, 2015
2. Biosensors, Edited by Pier Andrea Serra, InTech, ISBN 978-953-7619-99-2

Reference Books

1. Handbook of Biosensors and Biosensor Kinetics, Sadana & Sadana, 1st edition , Elsevier Science Print Book ISBN :9780444532626, eBook ISBN :9780080932859
2. Biosensors, Elizabeth A.H. Hall, Open university press, 1990
3. Electrochemical Biosensors - Review Paper-Sensor Principles and Architectures,DorotheeGrieshaber et al., , Sensors 2008, 8, 1400-1458

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	BIOMEDICAL APPLICATIONS USING FPGA'S.	Course Code	18MLBIPEFP
Credits	4	L-T-P	3-0-1

CO1 Analyse the digital blocks to report violations and synthesize to generate gate level netlist.

CO2 Design of RTL for various filters for given specifications.

CO3 Simulate and debug the design using test benches.

OVERVIEW OF DIGITAL SIGNAL PROCESSING

FPGA Technology:

Classification by Granularity ,Classification by Technology ,Benchmark for FPLs

DSP Technology Requirements :FPGA and Programmable Signal Processors

Design Implementation: FPGA Structure, The Altera EP2C35F672C6, Case Study: Frequency Synthesizer, Design with Intellectual Property Cores.

COMPUTER ARITHMETIC Number Representation: Fixed-Point Numbers ,Unconventional Fixed-Point Numbers ,Floating-Point Numbers **Binary Adders:** Pipelined Adders, Modulo Adders **Binary Multipliers:** Multiplier Blocks

Binary Dividers: Linear Convergence Division Algorithms, Fast Divider Design, Array Divider. Floating-Point Arithmetic Implementation: Fixed-point to Floating-Point Format Conversion ,Floating-Point to Fixed-Point Format Conversion, Floating-Point Multiplication, Floating-Point, Floating-Point Division, Floating-Point Reciprocal, Floating-Point Synthesis Results

Multiply-Accumulator (MAC) and Sum of Product (SOP): Distributed Arithmetic Fundamentals, Signed DA Systems, Modified DA Solutions.

Computation of Special Functions Using CORDIC: CORDIC Architectures

Computation of Special Functions using MAC Calls: Chebyshev Approximations, Trigonometric Function Approximation, Exponential and Logarithmic Function Approximation, Square Root Function Approximation

FINITE IMPULSE RESPONSE (FIR) DIGITAL FILTERS

Digital Filters FIR Theory: FIR Filter with Transposed Structure, Symmetry in FIR Filters,- phase FIR Filters Designing FIR Filters: Direct Window Design Method, Equiripple Design Method Constant Coefficient FIR Design: Direct FIR Design, FIR Filter with Transposed Structure, FIR Filters Using Distributed Arithmetic, IP Core FIR Filter Design, and Comparison of DA- and RAG-Based FIR Filters.

INFINITE IMPULSE RESPONSE (IIR) DIGITAL FILTERS: IIR Theory

IIR Coefficient Computation: Summary of Important IIR Design Attributes

IIR Filter Implementation: Finite Word length Effects, Optimization of the Filter Gain Factor Fast IIR Filter: Time-domain Interleaving, Clustered and Scattered Look-Ahead Pipelining, IIR Decimator Design, Parallel Processing, IIR Design Using RNS.

MICROPROCESSOR DESIGN: History of Microprocessors: Brief History of General-Purpose Microprocessors, Brief History of RISC Microprocessors, Brief History of PDSPs.

Instruction Set Design: Addressing Modes, Data Flow: Zero-, One-, Two- or Three-Address Design, Register File and Memory Architecture, Operation Support, Next Operation Location.

Software Tools: Lexical Analysis, Parser Development

FPGA Microprocessor Cores: Hardcore Microprocessors, Soft core Microprocessors

Case Studies: T-RISC Stack Microprocessors, LISA Wavelet Processor Design, Nios FFT Design

Text Book:

1. Digital Signal Processing with Field Programmable Gate Arrays, Uwe Meyer-Baese, Third Edition, Springer

Reference Books:

1. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design & Synthesis", SunSoft Press, 1st Edition, 1996, ISBN: 978-81-775-8918-4.
2. J Bhaskar , "Verilog Primer", Pearson / PHI, New Delhi, 3rd Edition, 2003

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	TELEMEDICINE	Course Code	18MLBIOETM
Credits	4	L-T-P	4-0-0

Course Outcomes:

CO1 : Demonstrates understanding of the underlying technology principles of a telemedicine system

CO2: Demonstrates awareness of the main approaches to providing remote solutions to deliver patient care.

CO3: Evaluate the process and business considerations when defining and implementing a telemedicine system in the remote.

INTRODUCTION TO TELEMEDICINE : Definitions of telemedicine – History of telemedicine – Organs and Forms of telemedicine – Evolution and benefits of telemedicine – Impact of telemedicine on healthcare delivery – Issues in telemedicine – Type of digital information (audio, video, still images, text and data)

ARCHITECTURE OF TELEMEDICINE SYSTEMS

Telemedicine as a system – Critical sub-systems of telemedicine – Regulatory sub-systems – Optional sub-system of telemedicine – Telecommunications Approach – Elements of telecommunications systems – PTOS, Wireless System. Modalities of telecommunications systems (e-health) – Wireless Communication and Satellite Communications – VSAT based dedicated videoconferencing system – Mobile applications of telemedicine (m-health).

COMPUTER AND NETWORKING TECHNOLOGIES FOR TELEMEDICINE

Internet based telemedicine practices – WWW approach - Applied web browser for healthcare practice – PC based Audio and Video conferencing – Types of network topologies – LAN, WAN and Body Sensor – Personal Area Network (Adhoc network) – 3 tier architecture model.

DATA AND INFORMATION STANDARDS IN TELEMEDICINE

Role of standards in Healthcare – Health Level Seven (HL7) – Digital Imaging and Communication in Medicine (DICOM), Logical Observation Identifiers Names and Codes

(LOINC), Systematized Nomenclature of Medicine – Clinical Terms (SNOMED) , Adoption of Information Systems Standards in Healthcare – Ethical and legal aspects of telemedicine, confidentiality of data, and the law, patient rights and consent-Security /access to medical Records, reimbursements. Values to the Patient, Clinician, and Health Care Organization training, cost, administration, Challenges to Successful Implementation – Healthcare Management Information Systems.

CLINICAL AND TECHNICAL ASPECTS OF TELEMEDICINE

Applications of telemedicine – Perspective of clinicians – Telemedicine and diagnostic imaging (teleradiology) – Telemedicine and monitoring of physiological parameters (telehealth) – Telemedicine and surgery (telesurgery). m-health - Diffusion of IT innovations in Healthcare – Healthcare Status, Delivery Systems & Issues in Developing Countries like India – Future of Healthcare – Challenges and Future Trends including Opportunities for rural and emergency

/disaster healthcare projects.

TEXT BOOKS:

1. Olga Ferrer Roca, M.Sosa Iudicissa (editors), "Hand book of Telemedicine", IOS press, 2002.
2. Norris.A.C, "Essentials of Telemedicine and Telecare", John Sons & Ltd, 2002.

REFEREN CES:

1. Wootton R, Craig J, Patterson V, "Introduction to Telemedicine", Royal Society of Medicine Press Ltd, London, 2nd edition, 2006, ISBN 1-85315-425-3.
2. Maheu, M.M.Whitten, P.Allen, "E-Health, Telehealth, and Telemedicine" Jossy-Bass, New York, 2001 ISBN: 0-7879-4420-3.
3. Latifi, R. "Current Principles and Practices of Telemedicine and e-Health" IOHS Press, Washington DC, 2008 ISBN: 978-1-85603-806-09.
4. Bashshur, R.L., Shannon G.W. "History of Telemedicine", New Rochelle NY: Mary Ann Liebert Publishers, 2009 ISBN: 978-1-934854-11-2.

Course Title	BIOMATERIALS	Course Code	18MLBIMC01
Credits	NIL	L-T-P	-----

CO1 Demonstrate an in-depth understanding to analyze and determine the material properties critically in order to select them for the required biocompatibility.

CO2 Work on multi disciplinary projects that involve extensive literature survey in the allied fields to arrive at optimal solutions considering patient safety

CO3 Utilize the acquired professional and intellectual integrity with the knowledge of ethical issues in the development of novel biomaterials

Biomaterials Science and Engineering: Multi levels of Structure and Categorization of Materials, Four Categories of Materials, Definitions of Biomaterials, Biomedical Materials and Biocompatibility

Toxicity and Corrosion : Elements in the Body, Biological Roles and Toxicities of Trace Elements, Selection of Metallic Elements in Medical-Grade Alloys, Corrosion of Metals, Environment inside the Body, Minimization of Toxicity of Metal Implants, Biological Roles of Alloying Elements

Mechanical Properties of Biomaterials: Role of Implant Biomaterials, Mechanical Properties of General Importance, Hardness, Elasticity: Resilience and Stretchability, Mechanical Properties Terms Used in the Medical Community, Failure, Essential Mechanical Properties of Orthopedic Implant Biomaterials

Metallic Biomaterials in Orthopedic Implants: Development of Metallic

Biomaterials, Stainless Steels, Cobalt-Based Alloys, Titanium Alloys, Comparison .Metallic Biomaterials: Dental Materials, NiTi Shape-Memory Alloys, Other Clinically Applied Metallic Materials, New Metallic Materials: Magnesium Alloys

Bioinert, Bioactive and Bioresorbable Ceramics: Overview of Bioceramics, Inert Bioceramics: Al_2O_3, ZrO_2, Types of Joints, Summary and Remarks, Dental Ceramics, Total Joint Replacement. Overview of Surface Bioactive and Bulk Degradable Ceramics, Calcium Phosphates and Hydroxyapatite, Bioactive Glasses, Bioactive Glass-Ceramics, Bone-Bonding Mechanisms, Biodegradable Ceramics, Bioceramic Scaffolds for Bone Tissue Engineering

Polymeric Biomaterials: Fundamentals, Basic Concepts on Polymers, Overview of Polymeric Biomaterials, Bioinert Polymers: Polyolefin, Poly(Ethylene Terephthalate), Acrylate Polymer, Fluorocarbon Polymers, Silicone, Polyurethane, Properties and Applications of Polyurethane as Biomaterials, Evolution of Biomaterials

Text Book:

1. Biomaterials: A Basic Introduction, Qizhi Chen, George Thouas, CRC Press Textbook, 2014, ISBN 9781482227697 - CAT# K22550

Reference Books:

1. Ratner, B. D., Hoffman, A. S., Schoen, F. J., Lemons, J. E. (2004). Biomaterial science: an introduction to materials in medicine. (2nd ed.). New York: Academic Press.
2. Park, J. B., &Bronzino, J. D. (2003). Biomaterials: principles and applications. CRC Press.

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	Technical Seminar	Course Code	L-T-P
Credits	2	18MLBIPCSR	0-0-2

The students should individually choose a seminar topic after discussion with subject experts from the Biomedical engineering field (such as doctors, industry personals, consultants, startups, etc). The student could convert the chosen seminar topic either into a Survey Paper or Technical Paper. The student must make a presentation on the scheduled dates and this will be evaluated by the committee for 25 Marks. Finally, the student must submit a technical seminar report and it will be evaluated for 25 Marks by the internal committee based on the seminar rubrics. Total internal assessment for the seminar would be 25+25=50 Marks. SEE will be conducted for 100 Marks and reduced to 50 Marks. The final marks would be CIE+SEE (50+50) = 100 Marks.

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

III Semester Core Subjects

Course Title	EMBEDDED SYSTEM DESIGN FOR BIOMEDICAL APPLICATIONS	Course Code	18MLBIPEES
Credits	4	L-T-P	3-1-0

CO1 Analyze the functional and non-functional requirements of embedded systems and develop solutions for health care applications (PO1-2)

CO2 Conceptualize and design embedded systems for optimal solutions considering issues related to safety, societal and environmental factors in the biomedical domain (PO2-2)

CO3 Extract information on concurrent problems through literature survey and analyze complex problems independently or in groups (PO1-2)

Embedded systems: Introduction, Characteristics, Classification, Generic architectures, Communication protocols, Overview of Real time operating systems, Medical applications with embedded software

Wireless medical systems: Introduction, Advances on Technologies for Implantable Bioelectronics, Lab on a Cellphone, A Wireless Intraoral Tongue–Computer Interface, Energy-Efficient Hierarchical Wireless Sensor Networks Based on Wake-Up Receiver Usage, Review of Signal processing for classification in wireless medical embedded systems

Algorithms and data processing : Framework for Biomedical Algorithm Design Cooperative Data Fusion for Advanced Monitoring and Assessment in Healthcare Infrastructures, Energy-Efficient High Data Rate Transmitter for Biomedical Applications

Power-Aware Scheduling Scheme for Medical Sensor SoC-Based WBAN Systems: Introduction, On-Time Power-Aware Scheduler, State transition models, Design, Typical power mode transition scenario, Structure of on-time power-aware scheduling system, Implementation details of implantable cardioverter-defibrillator (ICD) device and results

Case Studies: Embedded systems in a life supporting system, Embedded data logging platform for ECG and blood oxygenation monitoring, Real time monitoring systems, RTOS kernel in portable electrocardiograph, An Advanced Insulin Bolus Calculator for Type 1 Diabetes Combining Android and RTOS for medical devices, Embedded Software Quality Challenges in Medical Device Development

Text Books:-

B. Shibu K V: Introduction to Embedded Systems, Tata Mc Graw Hill, 2009
2. Wireless Medical Systems and Algorithms: Design and Applications, Pietro Salvo, Miguel Hernandez-Silveira, 2016, CRC Press
3. Tae-Ho Hwang et al. Sensors 2013, 13, 375-392

References:

1. Missomi Conti, Simone Orcioni et all, Lecture notes in electrical engineering Solutions on embedded systems, Springer science + business media BV 2011
2. Hassan Ghasemzadeh, Sarah Ostadabbas ,IEEE SENSORS JOURNAL, VOL. 13, NO.2, FEBRUARY 2013
3. Journal of Physics: Conference Series 332 (2011) 012006, IOP publishing
4. WhIte papers: Embedded–computIng.com, medsmagazIne.com, mentor.com/embedded

Course Title	PHYSIOLOGICAL CONTROL SYSTEMS AND MODELLING	Course Code	18MLBIPEPC
Credits	4	L-T-P	3-0-1

CO1: To Formulate the methods and techniques for analysis and synthesis of dynamic models

CO2: To describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software.

INTRODUCTION TO PHYSIOLOGICAL MODELING

Approaches to modeling: The technique of mathematical modeling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modeling. Introduction to physiology (homeostasis, cell biology) Modeling physicalsystems, linearmodels of physiological systems, Laplace transform, Transfer functions and block diagram analysis Physiology.

MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM

Dynamic systems and their control, modeling and block diagrams, the pupil control systems(Human Eye), general structure of control systems, the dynamic response characteristics of the pupil control system, open &close loop systems instability, automatic aperture control.

NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS

Nonparametric Modeling- Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modeling- Basic Parametric Model Forms and Estimation Procedures Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.

COMPARTMENTENTAL PHYSIOLOGICAL MODEL

Modeling the body as compartments, 48ehavior in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modeling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation. Mathematical modeling of the system: Thermoregulation, Thermoregulation of cold bloodedness& warm bloodedness, the anatomy of thermoregulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.

SIMULATION OF PHYSIOLOGICALSYSTEMS

Simulation of physiological systems using Open CV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity. Neuromuscular model, Renal System, Drug Delivery Model.

TEXT BOOKS:

B. Michel C Khoo, ―Physiological Control Systems -Analysis, simulation and estimation‖, Prentice Hall of India, 2001. 2. Marmarelis, ―Nonlinear Dynamic Modeling of Physiological Systems‖, Wiley-IEEE Press,2004.

REFERENCES:

1. Benjamin C Kuo, ―Automatic control systems‖, Tenth Edition, McGraw-Hill Education, 2017.

2. DavidTWestwick, Robert E. Kearney, Identification of Nonlinear PhysiologicalSystems, Wiley, IEEE Press, 2003. 3. V.Z. Marmarelis, ―Advanced methods of physiological modeling‖ , Springer, 1989 4. L.Stark,‖ Neurological Control System, Plenum Press‖,1968. 5. John H Milsum , 3. Biological control systems‖, McGraw Hill 1966 6. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su,―Advanced Computational Methods in Life System Modeling and Simulation‖, Spring

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	BRAIN COMPUTER INTERFACE	Course Code	18MLBIPEBC
Credits	4	L-T-P	3-1-0

Course outcomes

CO1. Apply the knowledge of mathematics science and engineering fundamentals to understand the Brain Organization, Anatomy, and Function.

CO2. Analyze and process the brain signals for artifact reduction.

CO3. Understand types of BCI, principles and its applications which are present state of art in the Neurosciences domain.

Introduction to BCI: Review of Basic Neuroscience, BCI concepts, Signal modalities in BCI – EEG based BCI/ Spike based BCI. Recording and Stimulating the Brain: Stimulating the Brain and Recording Signals from the Brain: Invasive Techniques & Noninvasive Techniques. Simultaneous Recording and Stimulation: Multi-electrode Arrays, Neurochip.

Signal Processing for BCI's: Spike Sorting, Frequency Domain Analysis: Fourier analysis, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT). Time Domain Analysis: Hjorth Parameters , Fractal Dimension, Autoregressive (AR) Modeling, Bayesian Filtering, Kalman Filtering. Principal Component Analysis (PCA) ,Independent Component Analysis (ICA) , Common Spatial Patterns (CSP). Artifact Reduction Techniques: Thresholding, Band-Stop and Notch Filtering, Linear Modeling, Principal Component Analysis (PCA), Independent Component Analysis (ICA).

Building a BCI: Major Types of BCIs: Brain Responses Useful for Building BCIs: Conditioned Responses, Population Activity, Imagined Motor and Cognitive Activity,

Stimulus-Evoked Activity. Invasive BCIs: Two Major Paradigms in Invasive Brain-Computer Interfacing: BCIs Based on Operant Conditioning, BCIs Based on Population Decoding.

Systems in BCI: Invasive – Cursor and Robotic Control Using a Multielectrode Array Implant, Cognitive BCIs in Humans, Long-Term Use of Invasive BCIs, Long-Term BCI Use and Formation of a Stable Cortical Representation, Long-Term Use of a Human BCI Implant Semi-Invasive BCIs: Electrocorticographic (EcoG) BCIs -EcoG BCIs in Animals, EcoG BCIs in Humans, BCIs Based on Peripheral Nerve Signals Nerve-Based BCIs, Targeted Muscle Innervation (TMR).

Non-Invasive BCIs: Oscillatory Potentials and ERD, Slow Cortical Potentials, Movement-Related Potentials, Stimulus Evoked Potentials; BCIs Based on Cognitive Tasks, Error Potentials in BCIs, Co-adaptive BCIs, Hierarchical BCIs. fMRI, MEG, and fNIR. BCIs that Stimulate: Sensory Restoration, Restoring Hearing: Cochlear Implants. Restoring Sight: Cortical and Retinal Implants, Motor Restoration, Deep Brain Stimulation (DBS), Sensory Augmentation. Spikes Based BCI and systems engineering in BCI -Neuro-stimulation

Applications of BCI: Medical - Sensory Restoration, Motor Restoration, Cognitive Restoration, Rehabilitation, Restoring Communication with Menus, Cursors, and Spellers, Brain- Controlled Wheelchairs. Nonmedical- Web Browsing and Navigating Virtual Worlds, High Throughput Image Search Lie Detection and Applications in Law. Estimating Cognitive Load, Education and Learning, Security, Identification, and Authentication. Ethics of Brain-Computer Interfacing: Medical, Health, and Safety Issues, Balancing Risks versus Benefits, Informed Consent, Abuse of BCI Technology, BCI Security and Privacy, Legal Issues, Moral and Social-Justice Issues.

TEXT BOOKS:

[1] Rajesh P. N. Rao, Brain-Computer Interfacing: An Introduction (1st Edition) Cambridge University Press

[2] Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction (The Frontiers Collection) Hardcover – (13 Dec 2010) by Bernhard Graimann (Editor), Brendan Z. Allison (Editor), GertPfurtscheller (Editor)

REFERENCE BOOKS:-

B. https://sccn.ucsd.edu/wiki/Introduction_To_Modern_Brain-Computer_Interface_Design

2. https://www.udemy.com/brain-computer-interface/

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	Project Phase-I	Course Code	L-T-P
Credits	10	18MLBIPWP1	0-0-10

- **Problem formulation** and submission of **synopsis** within 8 weeks from the commencement of 3rd semester, which shall be evaluated for 25 marks by the committee constituted for the purpose.
- **Literature survey and progress** done after 16 weeks, which shall be evaluated for 25 marks by the committee constituted for the purpose.

All the evaluation shall be done based on the rubrics of Project Phase – I. Total internal assessment for the Project Phase - I would be 25+25=50 Marks. SEE will be conducted for 100 Marks and reduced to 50 Marks. The final would be CIE+SEE (50+50) = 100 Marks.

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	Internship	Course Code	L-T-P
Credits	8	18MLBIPCIN	0-0-8

The student shall undergo internship for 16 weeks during III Semester.

- **Preliminary Report** submission and evaluation after 8 week of Internship carried out, which shall be evaluated for 25 marks by the committee constituted for the purpose.
- **Final Report** submission and evaluation after 16 week of Internship carried out shall be evaluated for 25 marks by the internal guide.
- **Viva-Voce on Internship** – The SEE shall be conducted by the Internship Guide (from the college) and the External Guide (from the internship company) within 2 weeks of submission for 100 Marks and reduced to 50 Marks. The final would be CIE+SEE (50+50) = 100 Marks.

IV Semester

Course Title	INNOVATION AND ENTREPRENEURSHIP	Course Code	18MLBIOEIE
Credits	4	L-T-P	3-1-0

Course Outcomes

CO1: Able to formulate goals as entrepreneur for a startup.

CO2: Able to Identify business opportunities by performing market research and choosing target customer

CO3: Designing and testing offering in terms of business logistics, pitching and selling to the customers.

Ideation and Innovation

Problems and Pain Points, Ideation and Problem Solving, Design Thinking, Team importance and Leadership, Market Segmentation, Beachhead Market, Building End User Profile, Total Addressable Market (TAM) Size for the Beachhead Market, Profile the Persona, Full Lifecycle Use Case, High-Level Product Specification, Quantify the Value Proposition, Identify Your Next 10 Customers, Define Your Core, Chart Your Competitive Position

Product Acquisition by customer

Determine the Customer's Decision Making Unit (DMU), Process to Acquire a Paying Customer, Mapping sale process, Total Addressable Market Size for Follow-on Markets

Business from Product

Design a Business Model, Set your Pricing Framework, Calculate the Lifetime Value (LTV) of an Acquired Customer, Map the Sales Process to Acquire a Customer, Calculate the Cost of Customer Acquisition (COCA)

Designing, building and scaling of the product

Identify key Assumptions, Test Key Assumptions, Define the Minimum Viable Product, Build an MVP, Test with Customer, Repeat Cycle to Reach Product Market Fit.

Startup and Entrepreneurship in India

Starting company in India, IP landscape, Incubation, Government support, Taxation, Startup culture and leadership, Open innovation, Social Innovation, Intrapreneurship, entrepreneurship in abroad.

Text Book :

1. Disciplined Entrepreneurship: 24 Steps to a Successful Startup (Wiley, 1st Edition) Bill Aulet, ISBN: 1118692284, 2013

Reference Books:

1. The Startup Owner's Manual: The Step-by-Step Guide for Building a great company by Steve Blank K&S Ranch Publishers, K&S Ranch, 2016
2. Innovator's Dilemma: When New Technologies Cause Great Firms to Fail by Christensen, Harvard Business Review Press, 2011

MOOC

1. https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring-2013/assignments/assignment-12/

Ebook:

1. https://segera-wisuda.blogspot.in/2016/05/46-ebooks-entrepreneurship-download-free.html

B.M.S COLLEGE OF ENGINEERING, BENGALURU-19

(Autonomous College under VTU)

Course Title	Project Phase - II	Course Code	L-T-P
Credits	20	18MLBIPWP2	0-0-20

The student should have satisfied Project Phase – I in their III semester before starting their Project Phase II. The student shall continue their project in the Company they are offered or shall work on their project in the PG laboratory of the college. The student doing their project in the college must mandatorily publish their work in a referred or non-paid journal. However, the students doing their project in the company would publish their work in a referred or non-paid journal subject to the preapproval of the company.

- **Midterm Report** submission and evaluation after 8 week of Project Phase – II, which shall be evaluated for 25 marks by the committee constituted for the purpose.
- **Plagiarism Check:** Before submission of the report, all the students must clear plagiarism check. The certificate along with plagiarism report shall be submitted to their guide before printing the report. Maximum acceptable plagiarism shall be as per the norms beyond that the students must resubmit the report after some modification. A due care shall be taken by the students

to follow the professional code of ethics and conduct. After which, the reports shall be prepared and printed as per the guidelines of M.Tech dissertation format.

- **Project Presentation:** After plagiarism checking process, the students shall make an open presentation in the department, which shall be evaluated for 25 marks by the committee constituted for the purpose.
- **Final Report** submission and evaluation after 16 week of Project Phase - II, which shall be evaluated for 100 marks by the internal guide. This would be part of SEE.
- **Viva-Voce on Project** – The SEE shall be conducted by the Internal Guide (from the college) and the External Guide (company or nominated) within 2 weeks of submission for 100 marks.

All the evaluation shall be done based on the rubrics of Project Phase – II. The final would be CIE (Midterm + Presentation) (100+100) + SEE (Report + VIVA) (100+100) = 400 Marks reduced to 100 marks finally.