ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)

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

(Autonomous College under VTU)

DEPARTMENT OF MEDICAL ELECTRONICS ENGINEERING

SCHEME & SYLLABUS
M.TECH PROGRAMME
in
BIOMEDICAL SIGNAL PROCESSING AND INSTRUMENTATION

I to IV SEMESTER
(Academic Year 2022 onwards)

ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

ಬುಲ್ ಟೆಂಪಲ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು–೫೬೦ ೦೧೯

B.M.S. COLLEGE OF ENGINEERING

Bull Temple Road, Bangalore - 560 019

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

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

The department will achieve the Vision through:

M1	Provide professional education in Medical Electronics Engineering, through Curriculum design and its effective implementation for holistic development
M2	Cater to the current healthcare-necessities of the society, through innovation and research in collaboration with Healthcare providers, Industry, Academia and Alumni
M3	Emphasis on professional ethics, contribution to society and concern for sustainable environment

PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

PEO1: Become successful professionals and leaders in the domain of Biomedical Signal Processing , Instrumentation and allied fields of Engineering.

PEO2: Engage in Lifelong learning processes through skill upgradation, research and development activities.

PEO3: Contribute to concurrent technological developments/changes also demonstrating professional ethics.

PROGRAM OUTCOMES (POs)

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 program are exemplars of the attributes expected of a graduate of an accredited program. The POs of the PG program are as follows:

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 be at a level higher than the requirements in the appropriate bachelor program.

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

Credit Distribution of the PG Program

Semester	Institute Core (HS)	Basics Science (Maths)	Professional Core	Professional Elective	Open Elective	Project/ Mini Project	Ability Enhancement Course	Industrial Training/ Internship	Non-credit Mandatory Course	Total Credits
I	2	4	13	-	3	-	2	-	-	24
II	-	-	11	6	3	2	2	-	-	24
III	-	-	-	3	-	10	-	3	02 Unit	16
IV	-	-	-	3	-	10	-	3	02 Unit	16
V	02	04	24	12	6	22	4	6	–	80

COURSE TYPES: -

Basic Science Course	BS
Institute Core Course (HS)	IC
Professional Elective Course	PE
Open Elective Course	OE
Ability Enhancement Course	AE
Project/ Mini-Project	PW
Industrial Training/ Internship	INT
Non-Credit Mandatory Course	NCMC

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

(Autonomous College under VTU)

I SEMESTER: SCHEME OF STUDY

Course Code		Course Title	Course Type	Credits			Total Credits	CIE	SEE	Total
				L	T	P				
22MABIPCMB		Mathematics for Biomedical Engineering	BS	2	1	0	3	50	50	100
22MDBIPCPE		Physiology for Biomedical Engineers	PC	2	0	0	2	50	50	100
22MDBIPCIA		Biomedical Image Processing and Analysis	PC	3	0	1	4	50	50	100
22MDBIPCBI		Biomedical Instrumentation	PC	3	0	1	4	50	50	100
22MDBIPCDD		Medical Device Development	PC	3	1	0	4	50	50	100
22MDBIHSRM		Research Methodology and IPR	HS	2	0	0	2	50	50	100
22MDB IOEXX	CV	Computer Vision	OE	3	0	0	3	50	50	100
	IT	Internet of Things								
22MDBIAECI		Clinical Immersion through Hospital Visit	AE	0	0	2	2	50	50	100
		Total		**18**	**2**	**4**	**24**	**400**	**400**	**800**

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

(Autonomous College under VTU)

II SEMESTER:

Course Code		Course Title	Type	Credits			Total Credits	CIE	SEE	Total
				L	T	P				
22MDBIPCIS		Medical Imaging Techniques & Systems	PC	3	0	0	3	50	50	100
22MDBIPCBS		Biostatistics	PC	3	0	1	4	50	50	100
22MDBIPCSA		Biomedical Signal Analysis	PC	3	0	1	4	50	50	100
22MDB IPEXX	VD	VLSI Design	PC	2	1	0	3	50	50	100
	MI	Medical Informatics								
	BR	Biomechanics and Rehabilitation Engineering								
22MDB IPEXX	BA	Biomaterials and Artificial Organs	PE	2	1	0	3	50	50	100
	ML	Machine Learning								
	VR	Virtual Reality								
22MDB IOEXX	BM	Biometrics	OE	3	0	0	3	50	50	100
	I4	Industry 4.0								
22MDBIPWMP		Mini Project	PW	0	0	2	2	50	50	100
22MDBIAEPP		Python programming for Biomedical Engineers	AE	0	0	2	2	50	50	100
		Total		**16**	**2**	**6**	**24**	**400**	**400**	**800**

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

(Autonomous College under VTU)

III SEMESTER:

Course Code		Course Title	Type	Credits			Total Credits	CIE	SEE	Total
				L	T	P				
22MDB IPEXX	ES	Embedded Systems	PE	2	1	0	3	50	50	100
	DA	Healthcare Data Analytics								
	PM	Photonics for Medical Imaging								
22MDBIPWP1		Project Phase- 1	PW	0	0	10	10	50	50	100
22MDBIINT1		Internship	INC	0	0	3	3	50	50	100
22MDBINC01		MOOC on BMSPI/Allied	NCMC	-	-	-	—	–	P/NP	–
22MDBINC02		Skill Enhancement Course on Deep Learning	NCMC	-	-	-	—	–	P/NP	–
		Total		**2**	**1**	**13**	**16**	**150**	**150**	**300**

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

(Autonomous College under VTU)

IV SEMESTER:

Course Code		Course Title	Type	Credits			Total Credits	CIE	SEE	Total
				L	T	P				
22MDB IPEXX	TM	Telemedicine	PE	2	1	0	3	50	50	100
	NI	Neuroimaging and Brain Mapping								
	HM	Hospital Management								
22MDBIPWP2		Project Phase- 2	PW	0	0	10	10	50	50	100
22MDBIINT2		Internship	INC	0	0	3	3	50	50	100
22MDBINC03		MOOC on BMSPI/Allied	NCMC	-	-	-	—	–	P/NP	–
22MDBINC04		Pedagogy Studies	NCMC	-	-	-	—	–	P/NP	–
		Total		**2**	**1**	**13**	**16**	**150**	**150**	**300**

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

COURSE TITLE	MATHEMATICS FOR BIOMEDICAL ENGINEERING	COURSE CODE	22MABIPCMB
Credits	3	L-T-P	2-1-0

•**Prerequisites:** Matrix Theory, Linear System of equations, Random variables, Binomial distribution, Poisson distribution, Exponential distribution.

Course Objectives:

- To provide the students with advanced concepts of linear algebra and probability theory which is essential for Medical Electronics Engineers.

UNIT-1

VECTOR SPACES: [8 hours]

Vector spaces and Subspaces, Linearly Independents sets; basses and dimension, coordinates of a vector, Fundamental subspaces (Row space, Column space and Null space).

UNIT-2

LINEAR TRANSFORMATIONS: [8 hours]

Linear transformations, Matrix of linear Transformation, Eigen vectors and Eigen values, eigen spaces, Applications to differential equations.

UNIT-3

ORTHOHONALITY AND LEAST SQUARES: [8 hours]

Inner Products, Inner products spaces, Norm, Orthogonality, orthogonal sets, orthogonal projections; Gram – Schmidt process; QR- factorization; least – squares problems.

UNIT-4

SYMMETRIC MATRICES AND QUADRATIC FORMS: [8 hours]

Diagonalization of symmetric matrices; quadratic forms; singular value decomposition, Application to image processing and statistics.

UNIT-5

PROBABITLY THEORY: [8 hours]

Random variable: Discrete and continuous, Probability distributions, probability mass function and density function, characteristic functions, probability generating and moment generating functions – illustrations. Geometric, Gaussian and Erlang distributions – examples.

Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO	Strength
22MABIPCMB	CO 1	Apply the concepts of, linear algebra and probability in Medical Electronics applications	PO1	3
	CO 2	Analyzing Medical images and data using matrix decomposition and probability theory.	PO2, PO3	3

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	Weightage	Total
CIE – Theory	AAT/PROJECT	10	50	10(100%)	50
	Paper presentation	10		10(100%)	
	Test 1	30		15(50%)	
	Test 2	30		15(50%)	
SEE	End Exam	100		50	

Two best scores out of the three tests will be considered for CIE.

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEMESTER END EXAMINATION:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question each from Units 2 & 3 and two questions each from Unit 1 and Unit 4.

SUGGESTED LEARNING RESOURCES:

Text Books:

1. David C. Lay, Steven R. Lay and J. J. McDonald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd. 2015.

2. Scitt L. Miller, Donald G. Childers: "Probability and Random Process with application to signal Processing", Elsevier Academic Processing", Elsevier Academic Press, 2nd Edition,2013.
3. Gilbert Strang: Introduction to Linear Algebra, 5th Edition, Wellesley – Cambridge Press, 2016.

Reference Books:

1. T. Veerarajan "Probability", Statistics and Random Process, 3rd Edition , Tata Mc-Graw Hill Co., 2016 Linear Algebra an Introduction, Richard & Gabiel B Costa, 2nd Edition.

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

COURSE TITLE	PHYSIOLOGY FOR BIOMEDICAL ENGINEERS	COURSE CODE	22MDBIPCPE
Credits	2	L-T-P	2-0-0

Pre Requisites: Basic Science Course Outcomes

CO1	Apply the knowledge of science and engineering of human anatomy and physiology to arrive at solutions for physiological problems.
CO2	Identify and analyze problems related to human anatomical systems and their typical features.
CO3	Use literature survey based knowledge to interpret data of contemporary investigations, demonstrate and document the same.

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2		3	
CO3			3
AVG	3	3	3

General Physiology: Cell, Cell junctions, Transport through cell membrane, Homeostasis, Acid base balance. Different mechanisms. Action potentials, Homeostasis, Controls and Feedbacks. Metabolic Rate: Definition, Bomb Calorimeter, Methods of determination of Metabolic Rate:

Direct and Indirect methods, Respiratory Quotient (RQ): Measurement of RQ, Roth spirometer, BMR; Factors influencing BMR. **[5 hours]**

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. **[5 hours]**

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, Hemorrhage.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

Physiology of Eye and Ear: Structure of the Eye, Visual process, Field of vision, Visual pathway, Pupillary reflexes, Color vision, Errors of refraction. ERG and EOG. Structure of ear, auditory defects. **[5 hours]**

Text Books

1 Essentials of Medical Physiology by K. Sembulingam and P. Sembulingam. Jaypee brothers medical publishers, New Delhi.

2 Principles of anatomy and physiology, Gerard j. Tortora, Bryan derrickson, 13th Edition, john Wiley & sons, Inc.

Reference Books:

1 Concise Medical Physiology" Sujit K. Chaudhuri, 5thEd, New Central BookAgncy2

Online courses:

1. https://oli.cmu.edu/jcourse/webui/syllabus/module.do?context =0477224b0a0001dc579a352e89762e86

E-Books:

1 https://openstax.org/details/books/anatomy-and-physiology-2e
2 https://open.umn.edu/opentextbooks/textbooks/fundamentals-of-anatomy-and-physiolog

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

COURSE TITLE	BIOMEDICAL IMAGE PROCESSING AND ANALYSIS	COURSE CODE	22MDBIPCIA
Credits	4	L-T-P	3-0-1

Pre Requisites: Mathematics and Digital signal Processing

Course Outcomes

CO1	Apply image processing algorithms for Medical Image processing
CO2	Conduct experiments using modern tools to develop and analyze algorithms to solve practical problems in biomedical image enhancement and analysis
CO3	Design open ended experiment for medical image segmentation and analysis and submit a technical report with reflection based learning
CO4	Design a Computer Aided tool for Medical Image Analysis and Publish a technical paper

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	2		
CO2	3		3
CO3	3	3	3
CO4	3	3	3
AVG	3	3	3

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. **8Hrs**

Image Enhancement in Spatial Domain: Spatial Domain image enhancement, basic gray level transformations, Histogram equalization, Smoothing spatial filters, Sharpening spatial filter **8Hrs**

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. **8Hrs**

Image Segmentation: 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.**8Hrs**

Analysis of shapes and textures: Chain codes, signatures, boundary segment, skeletons, boundary descriptors, texture, gray level co-occurrence matrix.

Concepts of morphological image processing: Dilation and erosion, Hit or miss transformations. **8Hrs**

Text Books

1 Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, Third Edition. Pearson Education Inc, 2012

2 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

Online courses:

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

2 scpd.stanford.edu

3 ocw.mit.edu

E-Books:

1 www.dcc.uchile.cl/~jsaavedr/libros/dip_gw.pdf

2 iclass.iuea.ac.ug

Lab Component (Applicable): LIST OF EXPERIMENTs:

1. Simulation and Display of an Image, Negative of an Image (Binary & Gray Scale)
2. Implementation of Relationships between Pixels
3. Implementation of Transformations of an Image
4. Contrast stretching of a low contrast image, Histogram, and Histogram Equalization
5. Display of bit planes of an Image
6. Display of FFT (1-D & 2-D) of an image
7. Implementation of Image Smoothening Filters (Mean and Median filtering of an Image)

8. Implementation of image sharpening filters and Edge Detection using Gradient Filters
9. Implementation of image restoring techniques
10. To restore the medical image
11. Morphological operations on Medical Image

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

COURSE TITLE	BIOMEDICAL INSTRUMENTATION	COURSE CODE	22MDBIPCBI
Credits	4	L-T-P	3-0-1

Pre Requisites: Electronics, Sensors and Measurements

Course Outcomes:

At the end of the Course students are able to

CO1	Acquire knowledge of Instrumentation and Control Engineering with ability to evaluate, analyze and synthesize knowledge related Biomedical Instrumentation / devices / systems.
CO2	Analyze complex problems related to Instrumentation and Control Engineering and synthesize the information for conducting biomedical related Experiments and research
CO3	Learn and use contemporary tools for solving problems related to Biomedical Instrumentation / systems/ devices, etc
CO4	Investigate and Summarize the findings or suggestions for the problems in current techniques and computing practice to improve Health care instruments through hospital visits for lifelong learning..
CO5	Write report of the case study for the usage of Therapeutic equipment and communicate the same individually and in a team

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2		3	
CO3	3		
CO4	3		3
CO5	3	3	3
AVG	3	3	3

Bioelectric Signals and Electrodes : Sources of biomedical signals, basic medical instrumentation system, PC based medical instruments, General constraints in design of medical instrumentation systems, origin of bioelectric signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes – Electrode-tissue interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes **8hrs**

Biomedical Recording and Patient Monitoring Systems:
Electrocardiograph-block diagram, ECG leads, effects of artifacts, multi-channel, ECG machine, Phonocardiograph-origin of heart sounds, microphones and amplifiers for PCG, Electroencephalograph- block diagram, computerized analysis of EEG, Electromyograph, biofeedback instrumentation.

Bedside monitors, Central Monitors, Measurement of Heart Rate, Average Heart Rate meter, Instantaneous heart rate meter, Measurement of pulse rate, Blood Pressure measurement ,Direct and indirect method, Automatic blood pressure measuring apparatus using Korotkoff's method. Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter, Bio-telemetry – Radio telemetry, Portable & Landline Telemetry for ECG **9hrs**

Blood Flow Meters, Cardiac Pacemakers and Defibrillators:
Electromagnetic blood flow meter, Types of electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters, Laser Doppler blood flow meters. Need for Cardiac pacemaker, External Pacemaker, Implantable Pacemaker, Types of Implantable Pacemaker, Ventricular Synchronous Demand Pacemaker and Programmable Pacemaker. Need for a defibrillator, DC defibrillator. Defibrillator electrodes, DC defibrillator with synchronizer. **7hrs**

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. 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. **8hrs**

Respiratory & Advanced Diagnostic & Therapeutic Instruments: Pulmonary function measurement, basic spirometer, ultrasonic spirometer, Pneumotachometer, Measurement of volume by Nitrogen washout technique. Artificial kidney-Principle and haemodialysis machine. Lithotripters- principle, modern lithotripter-block diagram and working. Anaesthesia-Need for anaesthesia, delivery of anaesthesia, anaesthesia machine. Infusion pumps-principle and programmable volumetric infusion pump. **8hrs**

Lab Component:

1. Design & Testing or DC Amplifier.
2. Design & Testing of Instrumentation Amplifiers.
3. Design & Testing of Isolation Amplifiers.
4. Measurement of Blood Pressure using Sphygmomanometer
5. Measurement of Oxygen Saturation and Heart Rate using Pulse Oximeter.
6. Measurement of Threshold using Audiometer and Plot its characteristics
7. Recording of Electrocardiogram using Biopac, power lab tutor
8. Recording of Electroencephalogram using Biopac, nexus 10 Neuro feedback system and ENO BIO
9. Pacemaker Analysis and plotting ECG using Pacemaker modular setup
10. Measurement of strain gouge using cantilever beam
11. Recording of Electromyogram using Biopac and pamtron EMG using ring electrodes
12. Determinations of Characteristics of Polarized and Non Polarized Electrodes.

13. Determination of temperature characteristics of thermocouple, thermistor RTD.
14. Analysis of surgical Diathermy
15. Study of syringe infusion pump, patient monitoring system,ECG, EEG using simulator

AAT: Case study through hospital visit and report writing

Text Books

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2009.
2. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice Hall of India, New Delhi, 2007.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.
4. Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGraw-Hill Publisher, UK,2003

Reference Books:.

1. G. Webster, Biomedical Instrumentation, John Wiley and Sons, Hoboken, NJ, 2004.
2. Biomedical Instrumentation by Dr.M. Arumugam-Second Edition-1994

Online courses:

1. Ma, Hongshen. 2.996 Biomedical Devices Design Laboratory, Fall 2007. (MIT OpenCourseWare: Massachusetts Institute of Technology), http://ocw.mit.edu/courses/mechanical-engineering /2-996-biomedical-devices-design-laboratory-fall-2007(Accessed 27 Jul, 2014). License: Creative CommonsBY-NC-SA
2. Lauffenburger, Douglas, Paul Matsudaira, Biological Engineering Faculty, and Angela Belcher. 20.010J Introduction to Bioengineering (BE.010J), Spring 2006. (MIT OpenCourseWare: Massachusetts Institute of Technology),http://ocw.mit.edu/courses/biological-engineering/20-010j-introduction-to-bioengineering-be-010j-spring-2006(Accessed 26 Jul, 2014). License: Creative Commons BY-NC-SA
3. http://oyc.yale.edu/biomedical-engineering/beng-100
4. Biomedical virtual laboratory link.
5. http://vlab1.iitr.ac.in/

E-Books:

1. http://www.ebook3000.com/Introduction-to-Biomedical-Instrumentation--The-Technology-of-Patient-Care_51854.html
2. Barbara Christe, Introduction to Biomedical Instrumentation: The Technology of Patient Care, Cambridge University Press | 2009 | ISBN: 0521515122

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

COURSE TITLE	Medical Device Development	COURSE CODE	22MDBIPCDD
Credits	4	L-T-P	3-1-0

Course Outcomes: At the end of the Course students are able to

CO1	Search, analyse and document clinical practice, engineering science and relevant literature in order to determine the need for further research and development in a chosen clinical area
CO2	Collect a range of data (both qualitative and quantitative) to analyze critically, reflect on and synthesize complex solutions to concepts and theories in a chosen topic
CO3	Ability to derive specifications and standards of a chosen device
CO4	Design a virtual device that helps to technologically address a clinical need in a team and document the same.

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	**3**		
CO2	**3**		
CO3	**3**	**3**	
CO4		**3**	**3**
AVG	**3**	**3**	**3**

Medtech Innovation: Introduction, the status of bio-innovation in India, DALY, MedTech Innovation, New medical device steps, Common Myths, Biodesign process, clinical immersion, need filtration, Need Specification document, case studies, Market Segmentation, Concept Generation and Selection, Perfint Maximo Example **8Hrs**

Product Requirement: Classification of Medical Device (FDA/ CE/ CDSCO), Requirement Analysis: Functional, Safety, Usability, User interface, Clinical Workflow, Internal Interface, Working environment, Infrastructure, Safety, Adaptability, Availability, User training, Labelling, Operating cost, Disposable, Design Input, ISO 13485 **8Hrs**

Design Engineering: Clinical Workflow, Design for Manufacturing, Design for Serviceability, FMEA, Economy of Scale, Standards in Medtech, Safety and Risk Management, Case studies. **8Hrs**

Human Factor Engineering: HE75, Common UI and UA issues, Economy of Scale, Product Requirements, Design engineering, Practical Development process, Importance of verification and review, Iterative development, Design and development plan, Design Output, Design Process, Design Verification, Design Validation, Design Review, Review versus verification versus validation, Design Transfer, Functional Block Diagram, High-Level Design, Signal flow path / Signal Characteristics **8Hrs**

Project Management and sustainability: Activity Planning - Objectives, Defining Activities, Project Plan (Gantt Chart), Network Planning models - Critical path management (CPM), Precedence Network, Nodes, Activity

network, Forward Pass, Backward Pass, Float, Critical Path and its importance Sustainability: Need, external push towards sustainability, hospital role, barriers, making sustainable device, examples. **8Hrs**

Text Books

1. Biodesign: The Process of Innovating Medical Technologies, by Paul Yock, Stefanos A. Zenios, and Todd J. Brinton, Cambridge University Press, 2nd edition, 2015

2. Inventing Medical Devices: A Perspective from India, by Jagdish Chaturvedi, Notion Press, 2017Reference Books:1The Medical Device R&D Handbook, by Theodore R. Kucklick, Second Edition, CRC Press, 2012

Online courses:

1. Pharmaceutical and Medical Device Innovations Coursera Medical Technology and Evaluation Coursera
2. Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0) - Course Swayam

E-Books:

1. http://ebiodesign.org/
2. https://generisgp.files.wordpress.com/2016/05/ebook-medical-device-developmentbest- practices.pdf

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

COURSE TITLE	RESEARCH METHODOLOGY & IPR	COURSE CODE	22MDBIHSRM
Credits	2	L-T-P	2-0-0

Course Outcomes: At the end of the Course Students are able to

CO1	Write and present a substantial technical report/ document
CO2	Demonstrate a degree of mastery over the area of specialization

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1		1	
CO2			3
AVG		1	3

Meaning and sources of research problem- Objectives and Characteristics of research–Errors in selecting research problem, Research methods Vs Methodology - Types of research-Criteria of good research – Developing a research plan **[5 hours]**

Investigations of a research problem - Selecting the problem - Necessity of defining the problem–Data collections-analysis- Importance of literature review in defining a problem - Survey of literature - Necessary instrumentations. **[5 hours]**

How to write paper-conference articles-poster preparation, thesis report

writing, inclusion of references, journal reviewing process, journal selection process, filling about journal template, developing effective research proposal-plagiarism-research ethics. **[5 hours]**

Nature of Intellectual property (IPRs)- Invention and Creativity - Importance and Protection of Intellectual Property Rights (IPRs) –procedure for grant of patents and patenting under PCT-types of patents technological research and innovation- international cooperation on IP. **[5 hours]**

A brief summary of Patents-Copyrights-Trademarks, patent rights-licensing and transfer of technology patent databases-case studies on IPR-Geographical indications-new developments in IPR-protection of IPR rights **[5 hours]**

Text Books

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

Reference Books:

1. Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
2. Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

Online courses:

1https://onlinecourses.nptel.ac.in/noc22_ge08/preview

E-Books:

1 https://dst.gov.in/sites/default/files/E-BOOK%20IPR.pdf

2 https://www.pdfdrive.com/methodology-and-research-design-methodology-and-research-design-e58360328.html

Alternate Assessment Test1:- The topic will be announced in the first week of the semester and the students should submit within a month.

Topic: Using the concepts studied students are expected to carry out research in their field of interest and present a substantial technical report/document-10M.

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

COURSE TITLE	COMPUTER VISION	COURSE CODE	22MDBIOECV
Credits	3	L-T-P	3-0-0

Course Outcomes

CO1	Develop a technical document for the designed vision based system
CO2	Demonstrate scholarship of knowledge through performing mathematical analysis of the computer vision based systems
CO3	Demonstrate scholarship of knowledge through simulation / conducting experiments to develop an application in the computer vision domain

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2		3	
CO3			3
CO4			
AVG	3	3	3

Cameras: Pinhole Cameras**:** Perspective Projection, Affine Projection. Radiometry—Measuring Light: Light in Space, Foreshortening, Solid Angle, Radiance, Light at Surfaces, Simplifying Assumptions, The Bidirectional

Reflectance Distribution Function, Example: The Radiometry of Thin Lenses. Linear Filters: Linear Filters and Convolution, Shift Invariant Linear Systems, Spatial Frequency and Fourier Transforms, Sampling and Aliasing, Filters as Templates, Normalized Correlation and Finding Patterns, Scale and Image Pyramids. **[8 hours]**

Texture: Representing Texture, Analysis (and Synthesis) Using Oriented Pyramids, Application: Synthesizing Textures for Rendering Shape from Texture. The Geometry Of Multiple Views: Two Views: Epipolar Geometry, The Calibrated Case, Small Motions, The Uncalibrated Case, Weak Calibration Three Views: Trifocal Geometry, The Calibrated Case ,The Uncalibrated Case, Estimation of the Trifocal Tensor Stereopsis: Reconstruction: Image Rectification, Human Stereopsis, Binocular Fusion, Using More Cameras **8 hours]**

Segmentation By Clustering: What Is Segmentation?, Human Vision: Grouping and Gestalt, Shot Boundary Detection and Background Subtraction, Image Segmentation by Clustering Pixels , Segmentation by Graph-Theoretic Clustering Segmentation By Fitting A Model : The Hough Transform, Fitting Lines , Fitting Curves , Fitting as a Probabilistic Inference Problem, Robustness : M-estimators, RANSAC, Example: Using RANSAC to Fit Fundamental Matrices **[8 hours]**

Tracking With Linear Dynamic Models: Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering , Data Association, Applications and Examples :Vehicle Tracking **[8 hours]**

Model-Based Vision: Initial Assumptions, Obtaining Hypotheses by Pose Consistency ,Obtaining Hypotheses by Pose Clustering , Obtaining Hypotheses Using Invariants , Verification, Application: Registration in Medical Imaging Systems, Curved Surfaces and Alignmen **[8 hours]**

Text Books

1 Computer Vision: A Modern Approach by David A. Forsyth, Jean Ponce, 2nd Edition, Pearson Education, 2015.

Reference Books:

1 Computer Vision: Algorithms and Applications, by Richard Szeliski, Springer,2011 2.

2 Multiple View Geometry in Computer Vision by Richard Hartley and Andrew Zisserman , Second Edition,Cambridge University Press,2004.

Online course

1 https://www.udemy.com/course/computer-vision-

2 https://www.coursera.org/specializations/firstprinciplesof computervision

E-Books:

1 https://www.pdfdrive.com/computer-vision-algorithms-and-applications-e187353762.html

2 https://kgut.ac.ir/useruploads/1550563201478ety.pdf

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

COURSE TITLE	INTERNET OF THINGS	COURSE CODE	22MDBIOEIT
Credits	3	L-T-P	3-0-0

Pre Requisites: Knowledge of Internet, Communication and system architectures

Course Outcomes:-
At the end of the course, students will have the ability to

CO1	Independently investigate and develop solutions based on application of IoT.
CO2	Comprehend and analyze the architectures, the things and the data analytics of an IoT application, and write a report and present it.
CO3	Demonstrate a degree of mastery in the IoT design and development.

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2		3	
CO3			3
AVG	3	3	3

Introduction: - Genesis of IoT – Evolutionary phases of the Internet, IoT and digitization. Characteristics of IoT, Ecosystem, Applications of IoT, Impact on Connected roadways, Factories, Buildings and Creatures, Convergence of IT and IoT, Market place of IoT, Challenges. **8 Hrs**

IoT Network Architecture and Design :- Introduction, Drivers behind architecture, Comparison of IoT architectures. , IoT – Reference models. IoT data management and compute stack, Fog and Edge computing **8 Hrs**

The Things in IoT:- Sensors, Actuators, MEMS, Smart objects, Sensor networks. Connecting the smart objects: Range , Frequency bands, Power consumption, Topology, Constrained-devices and –node networks, IoT Access technologies – Overview and example of ZigBee, **8 Hrs**

Data Analytics for IoT:- Introduction, Structured versus Unstructured data, Data in motion versus data at rest. IoT data analytics – overview, Challenges. Machine learning – overview, Neural network example. Machine learning and getting intelligence from big data. Predictive analytics. Edge streaming analytics, Network analytics. **8 Hrs**

IoT in Industry:- Connected Manufacturing- Introduction, IoT Strategy, Business improvements, The ISA99 logical framework**.** Oil and Gas industries – Introduction, Current trends, Digitization drivers, challenges and requirements, Benefits. Public Safety: Overview, IoT blueprint for public safety, Emergency response IoT architecture. **8 Hrs**

Text Books

1. David Hanes, Gonzalo Salguiro, Patrick Grossetete, Rob Barton, and Jerome Henry, IoT Fundamentals, 1st Edition, 2018, CISCO Press, Pearson Education Inc.

2. Srinivasa K.G, Siddesh G.M, Hanumantha Raju R, Internet of Things, 1st edition, 2017, Cengage Learning India Pvt Ltd.

Reference Books:

1. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, 1st edition, 2014, Wiley
2. B.K. Tripathy and J. Anuradha, Internet of Things, 1st Edition, 2018, CRC Press Taylor & Francis GroupQusay F. Hassan, Internet of Things A to Z - Technologies and Applications, 1st edition, 2018, IEEE Press, Wiley

Online courses:

1. https://www.coursera.org/learn/iot
2. https://online.stanford.edu/courses/xee100-introduction-internet-things
3. https://www.edx.org/learn/iot-internet-of-things
4. https://onlinecourses.nptel.ac.in/noc19_cs65/preview

E-Books:

1. https://www.pdfdrive.com/internet-of-things-books.html
2. https://www.amazon.in/Introduction-IoT-Sudip-Misra-ebook/dp/B08X14D8FH

Alternate Assessment Test 1:- Presentation on a case study of IoT application

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

COURSE TITLE	CLINICAL IMMERSION THROUGH HOSPITAL VISIT	COURSE CODE	22MDBIAECI
Credits	2	L-T-P	0-0-2

Pre Requisites:

Course Outcomes:- At the end of the course, students will have the ability to

CO1	contextual learning to apply the knowledge in the design of medical devices, to identify unmet needs and opportunities for innovation
CO2	Prepare the technical report on the clinical immersion

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2		3	
AVG	3	3	

Guidelines

1. Clinical Immersion course provides a valuable opportunity for students to observe and interface with clinicians in their work environment to better enable them to methodically identify opportunities and requirements, while avoiding the product design gap, resulting from a failure to fully understand the customer's needs. Immersion experiences are important in permitting students to experience user-centered design

2. Clinical Immersion through Hospital Visit offered to provide exposure to the clinical environment, including process flow, workarounds, and a first-hand understanding of where and how medical devices are used. The primary learning objective is to formalize a methodical approach to needs assessment based on user-centered design. Upon completion of the Bioengineering Clinical Immersion program, students are well prepared for the design and development of medical devices conceived from validated end-user needs.
3. Students will have to visit various departments in the hospital for 4-8 weeks to get exposure about medical instruments used in hospital, physiological data acquisition. Students are expected to discuss with doctors/ experts to understand unmet need. This in term will be useful for Mini Project/ Major Project work.
4. Students will give presentation on Hospital visit experience and prepare the in detail report on their hospital visit experience and Need identification.
5. Students will be evaluated by the Committee in the department. Based on presentation and report submission CIE marks will be given.
6. For SEE students will give presentation in presence of external examiner and marks will be given based on the Presentation and Report prepared.

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

(Autonomous College under VTU)

COURSE TITLE	MEDICAL IMAGING TECHNIQUES AND SYSTEMS	COURSE CODE	22MDBIPCIS
Credits	3	L-T-P	3-0-0

Course Outcomes

CO1	Apply the knowledge of mathematics, science, Engineering fundamentals to investigate the medical signals and systems to solve practical problems.
CO2	Acquire in-depth knowledge of Medical Imaging principles and their applications to demonstrate a degree of mastery over the area in a program.
CO3	Identify potential issues in an imaging system, arrive at feasible and optimal solutions after considering public health and safety in the core areas of expertise.
CO4	Use modern tools and techniques to conceptualize the image acquisition through mathematical principles to form the final image shown to the doctors. Present and document the same.
CO5	Through literature survey extract information to the unfamiliar problems, interpret and demonstrate viewing things in a broader perspective. Document the results and present the same

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	**3**		
CO2			**3**
CO3	**3**		**3**
CO4	**3**	**3**	
CO5		**3**	**3**
AVG	**3**	**3**	**3**

Introduction to Medical Imaging: Basic imaging principle, Imaging Modalities-Projection radiography, Computed Tomography, Nuclear medicine, Ultrasound imaging, Magnetic Resonance Imaging. X-Ray and Radiography: Interaction between X-Rays and matter, Intensity of an X-Ray, Attenuation, X-Ray Generation and Generators, Beam Restrictors and Grids, Intensifying screens, fluorescent screens and Image intensifiers, X-Ray detectors, Conventional X-Ray radiography, Fluoroscopy, Angiography, Digital radiography, X-Ray image characteristics, Biological effects of ionizing radiation. **8Hrs**

Computed Tomography : Conventional tomography, Computed tomography principle, Generations of CT machines – First, Second, Third, Fourth, Fifth, Sixth & Seventh, Projection function, Reconstruction algorithms – Back Projection Method, 2D Fourier Transform Method, Filtered Back Projection Method, Iteration Method, Parallel Beam Reconstruction, Fan Beam Reconstruction, Helical CT Reconstruction **8Hrs**

Ultrasound Imaging: Acoustic propagation, Attenuation, Absorption and Scattering, Ultrasonic transducers, Transducer Arrays, A mode, B mode, M mode scanners, Tissue characterization, Colour Doppler flow imaging, Echocardiography. **6Hrs**

Radionuclide Imaging: Interaction of nuclear particles and matter, Nuclear sources, Radionuclide generators, Nuclear radiation detectors, Rectilinear scanner, scintillation camera, SPECT, PET. **5Hrs**

Infrared Imaging: Physics of thermography – imaging systems – pyroelectric vidicon camera clinical thermography – liquid crystal thermography. **5Hrs**

Magnetic Resonance Imaging: Angular momentum, Magnetic dipole moment, Magnetization, Larmor frequency, Rotating frame of reference, Free induction decay, Relaxation times, Pulse sequences, Generation and Detection of NMR Imager. Slice selection, Frequency encoding, Phase encoding, Spin-Echo imaging, Gradient-Echo imaging, Imaging safety, Biological effects of magnetic field, Introduction to Functional MRI. Application, Functional Imaging, Echoplanar imaging, MR Angiography, Cardiac MRI **8Hrs**

Text Books

1 Principles of Medical Imaging, K Kirk Shung, Michael B Smith & Benjamim M W Tsui, Academic Press Inc.

2 Hand Book of Biomedical Instrumentation, R S Khandpur, Tata McGraw Hill Publication, Second Edition.

Reference Books:

1 Medical Imaging Signals and Systems, Jerry L Prince & Jonathan M Links, Pearson Prentice Hall.

2 The physics of medical imaging, Steve Webb, Adam Hilger, Bristol, England, Philadelphia, USA, 1988.

3 Basics of MRI, Ray H Hashemi & William G Bradley Jr, Lippincott Williams & Wilkins.

4 Diagnostic Ultrasound Principles & Instruments, 5th Edition, Frederick W Kremkau.

5 2D Echocardiography, Jay N Schapira, Williams & Wilkins

Online courses:

1 **edX MOOC Course, Principles of Biomedical Imaging, online course.**

2 NPTEL VIDEO LECTURES AND NOTES

e-books

1 https://www.pdfdrive.com/medical-imaging-principles-detectors-and-electronics-e33410559.html

Alternate Assessment Test1:- Case study based presentation

COURSE TITLE	BIOSTATISTICS	COURSE CODE	22MDBIPEBS
Credits	4	L-T-P	3-0-1

Course Outcomes

CO1	Analyze the role of biostatistics in public health or medical studies
CO2	Use descriptive tools to summarize and display data from a public health or medical studies
CO3	Identify the study designs and appropriate tests to perform hypothesis testing and interpret the outputs
CO4	Formulate and perform a descriptive and inferential analysis of a public health or other health sciences study using statistical Software and interpret the results and prepare the report

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	2		
CO2	3		
CO3	3		3
CO4	3	3	3
AVG	3	3	3

Introduction to Biostatistics: Introduction, Some basic concepts, Measurement and Measurement Scales, Simple random sample, Computers and biostatistical analysis. Descriptive Statistics: Introduction,

ordered array, grouped data-frequency distribution, descriptive statistics – measure of central tendency, measure of dispersion, measure of central tendency computed from grouped data, variance and standard deviation-grouped data. **4Hrs**

Basic Probability Concepts: Introduction, two views of probability – objective and subjective, elementary properties of probability, calculating the probability of an event. Probability Distributions: Introduction, probability distribution of discrete variables, binomial distribution, Poisson distribution, continuous probability distributions, normal distribution and applications. **4 Hrs**

Sampling Distribution: Introduction, sampling distribution, distribution of the sample mean, distribution of the difference between two samples means, distribution of the sample proportion, distribution of the difference between two sample proportions. Estimation: Introduction, confidence interval for population mean, t-distribution, confidence interval for difference between two population means, population proportion & difference between two population proportions, determination of sample size for estimating means, estimating proportions, confidence interval for the variance of normally distributed population & ratio of the variances of two normally distributed populations. **6 Hrs**

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, completely randomized design, randomized complete block design, repeated measures design, factorial experiment. **6 Hrs**

Linear Regression and Correlation: Introduction, regression model, sample regression equation, evaluating the regression equation, using the regression equation, correlation model, correlation coefficient. Multiple Regression and Chi-Square Distribution: Multiple linear regression model, obtaining multiple regression equation, evaluating multiple regression equation, using the multiple regression equation, multiple correlation model, mathematical properties of Chi-square distribution, tests of goodness of fit, tests of independence, tests of homogeneity, nonparametric regression analysis. **5 Hrs**

Text Books

1 Biostatistics: A Foundation for Analysis in the Health Sciences, 11th Edition Wayne W. Daniel, Chad L. Cross, Wiley publishers, 2018.

2 Biostatistics with R: An Introduction to Statistics Through Biological Data by Babak Shahbaba, Springer, 2012

Reference Books:

1 Biostatistics for the Biological and Health Sciences, 2nd edition by Marc M. Triola, Mario F. Triola, Jason Roy, Pearson publishers, 2017

2 Rosner B. Fundamentals of Biostatistics, 8th ed. Cengage Learning, Boston, MA, 2016

Online courses:

1 Online course Introduction to Applied Biostatistics: Statistics for Medical Research edX

2 Introduction to Biostatistics - Course - Swayam

E-Books:

1.Biostatistics: for self-learning – WHO

Lab Component

List of Experiments: –	
Sl.No	Title of the Experiment
1	Explore the AGE data in sample with a stem-and-leaf plot and frequency table.
2	To calculate and interpret summary statistics for the given data in the sample.
3	To calculate and interpret binomial and normal probabilities. a) A Binomial Problem b) Normal probability problem
4	Distributions of sample means and confidence intervals for means.
5	To test a sample mean against a hypothesized "null value."
6	To describe differences in paired samples, calculate a confidence interval, a paired mean difference, and test a paired difference for significance.
7	To describe independent samples, estimate a mean difference

8	with 95% confidence, and conduct an independent t test. To estimate the prevalence of HIV in the population and to calculate the sample size needed to estimate this prevalence with a margin of error of 0.1 (10%).
9	Formulate and perform a descriptive and inferential analysis of a public health or other health sciences study and interpret the results and to write a paper for the interpretation of results.

Alternate Assessment Test1:- The topic will be announced in the first week of the semester and the students should submit within a month.

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

COURSE TITLE	BIOMEDICAL SIGNAL ANALYSIS	COURSE CODE	22MDBIPCSA
Credits	4	L-T-P	3-0-1

Pre Requisites: Signals and Systems

Course Outcomes

CO1	Apply the knowledge of mathematics, science, Engineering fundamentals to understand the concepts.
CO2	Acquire in-depth knowledge of Bio Medical Signals and characteristics.
CO3	Think laterally and originally, conceptualize and solve engineering problems, identify potential issues in an signal analysis evaluate a wide range of potential solutions for those issues and arrive at feasible, optimal solutions after consideri ng public health and safety, societal and environmental factors in the core areas of expertise.
CO4	Use modern tools, apply appropriate techniques and modern engineering and programming tools, to understand the concepts of signal acquisition, mathematical principles underlying the signal processing , acquisition and transformation of the signal to form the final image shown to the doctors
CO5	Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective. Document and present the same.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2			3
CO3	3		3
CO4	3	3	
CO5		3	3
AVG	3	3	3

Preliminaries: Biomedical signal origin & dynamics (ECG ,EEG, EMG etc.). Filtering for Removal of artifacts: Statistical Preliminaries, Time domain filtering (Synchronized Averaging, Moving Average), Time domain filtering (Moving Average Filter to Integration, Derivative-based operator), Frequency Domain Filtering (Notch Filter), Optimal Filtering: The Weiner Filter. Optimal Filtering: The Weiner Filter, Adaptive Filtering Selecting Appropriate Filter. **8Hrs**

Event Detection: Example events (viz. P, QRS and T wave in ECG), Derivative based Approaches for QRS Detection Pan Tompkins Algorithm for QRS Detection, Dicrotic Notch Detection Correlation analysis of EEG Signal,Case Studies. **8Hrs**

Waveform Analysis: Illustrations of problem with case studies,

Morphological Analysis of ECG, Correlation coefficient, The Minimum phase correspondent. Signal length, Envelop Extraction, Amplitude demodulation, The Envelogram, Analysis of activity, Root Mean Square value, Zero-crossing rate, Turns Count, Form factor. **8Hrs**

Frequency-domain Analysis: Periodogram, Averaged Periodogram, Blackman-Tukey Spectral Estimator, Daniell's Spectral Estimator, Measures derived from PSD. **8Hrs**

Modelling of Biomedical Systems: Motor unit firing pattern, Cardiac rhythm, Formants and pitch of speech, Point process, Parametric system modelling, Autoregressive model, Autocorrelation method, Application to random signals, Computation of model parameters, Levinson-Durbin algorithm, Computation of gain factor, Covariance method, Spectral matching and parameterization, Model order selection, Relation between AR and Cepstral coefficients. **8Hrs**

Text Books

1 R M Rangayyan "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002

2 Willis J. Tompkins " Biomedical Digital Signal Processing", EEE, PHI, 2004

3 D C Reddy "Biomedical Signal Processing: Principles and Techniques", Tata McGraw-Hill Publishing Co. Ltd, 2005

Reference Books:

1 J G Webster "Medical Instrumentation: Application & Design", John Wiley & Sons Inc., 2001

2. C Raja Rao, S K Guha "Principles of Medical Electronics and Biomedical Instrumentation", Universities Press, 2001

3. AV Oppenheim and RW Shafer "Discrete-time Signal Processing", Prentice Hall, Englewood Cliffs, NJ, 1989.

4. Steven M. Kay, "Modern spectral estimation theory and application ", Prentice Hall, Englewood Cliffs, NJ, 1985

Online courses:

1. https://engineering.purdue.edu/online/courses/biomed-signal-processing

E-Books:

1. biomedical signal analysis contemporary methods and applications

2. https://in.mathworks.com/discovery/biomedical-signal-processing.html

Lab Component :List of Experiments:

Display of an ECG wave, display of an ECG wave with noise, Filtering of a noisy ECG signal, Filtering of a corrupted ECG with two pole IIR LP, HP, BR filters. Display of a noisy ECG and filtering with integer LP,HP, BP filters. QRS detection and Heart rate measurement. Computation of Power Spectral Density (PSD) of an ECG. Display of a noisy ECG and filtering with a Notch filter. Compression of an ECG signal using the Turning Point algorithm, Perform signal averaging to remove a random noise present in the ECG.

COURSE TITLE	VLSI DESIGN	COURSE CODE	22MDBIPEVD
Credits	3	L-T-P	2-1-0

Pre-Requisites: Basic Electronics and Digital Electronics

Course Outcomes

CO1	understand, define the fundamentals of CMOS technology.
CO2	apply the knowledge of CMOS technology to construct basic and advanced CMOS logic circuits.
CO3	To investigate and simulate CMOS circuits for given specifications.
CO4	Design and analyze CMOS circuits to arrive at suitable conclusions

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		3
CO2	3		3
CO3	3	2	3
CO4	3		3
AVG	3	2	3

Logic Design with MOSFETs: MOSFETs as Switches, Basic logic gates in

CMOS, Complex logic gates in CMOS, Transmission Gate Circuits.Physical Structure of CMOS Integrated Circuits: Integrated Circuit Layers, Interconnect Resistance and Capacitance, MOSFETs CMOS layers, Designing FET Arrays, Complex logic gates, Gate layout geometry, Euler graph. **[8hours]**

Electronic Analysis of CMOS Logic Gates: DC Characteristics of the CMOS inverter, Inverter Switching Characteristics, Power dissipation, DC Characteristics: NAND and NOR Gates. **[8hours]**

Basic circuit concepts: sheet resistance R, sheet resistance concept applied to MOS transistor and inverter, area capacitances of layers, standard unit of capacitance Cg, some area capacitance calculation, the delay unit τ, inverter delays, driving large capacitance loads, propagation delays, wiring capacitance, choice of layers. **[8hours]**

Scaling of MOS circuits: Scaling models and scaling factors for device parameters, some discussions on scaling and limitations of scaling, subsystem design and layout. Some architectural issues, switch logic gate restoring logic. Examples of structured design **[8hours]**

F**abrication of CMOS integrated circuits**: Overview of silicon processing, material growth and deposition, lithography, CMOS process flow **[8hours]**

Text Books

1. John P. Uyemura, "Introduction to VLSI Circuits & Systems", Wiley India Edition, 2007, ISBN: 978-81-265-0915-7.

2.Basic VLSI design- Dougles A Pucknell, 3rd edition, PHI.

Reference Books:

1. Principles of CMOS VLSI design-Neil West and Eshranghian, 2nd edition, Addison Wesley, 2002.
2. M.S.Suma,Poornima M,Namita Palecha,CMOS VLSI Design, New Age International,1st Edition 2017.

Online courses:

1. ElectronicDesignAutomationhttp://nptel.ac.in/courses/VLSI Fundamentals.

E-Books:

1. http://access.ee.ntu.edu.tw/course/dsd_99second/2011_lecture /W2_HDL_Fun damentals_2011-03-02.pdf

Alternate Assessment Test1:- The topic will be announced in the first week of the semester and the students should submit within a month.

Topic: Using the concepts studied students are expected to design any circuit.

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

COURSE TITLE	MEDICAL INFORMATICS	COURSE CODE	22MDBIPEMI
Credits	3	L-T-P	2-1-0

Pre Requisites: DBMS, biomedical concepts, Management principles

Course Outcomes

CO1	Explore how technology can be used to improve health care delivery in health care organizations and in public health
CO2	Acquire breadth of knowledge of the principles of health informatics.
CO3	Develop basic skills in using health informatics principles to improve practice
CO4	Acquire a conceptual and theoretical framework of the design, development, and implementation of health information systems.
CO5	Develop Programming skills in Java and script languages

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		3
CO2	3		3
CO3	3		3
CO4	3		3
CO5	3		3
AVG	3		3

INTRODUCTION

Historical highlights and Evolution of Health informatics, Hospital Information System – its characteristics and functional online and offline modules, Health Informatics, Bioinformatics, Medical Informatics, Clinical Informatics, imaging Informatics, Nursing Informatics, Public Health Informatics, e – health services, Evidence Based Medicine, Bioethics, Virtual Hospital, Consumer Health Informatics and Healthcare Data Analytics. 22 **8Hrs**

ELECTRONICS PATIENT RECORDS AND STANDARDS

Electronic Patient Record, Medical data formats, – Medical Standards and Organizations – HL7 – DICOM - IRMA - LOINC - PACS - Medical Standards for Vocabulary - ICD 10, DRGs, MeSH, UMLS, SNOMED – JCAHO – HIPAA. **8Hrs**

BIOINFORMATICS AND TECHNOLOGIES

Bio-information technologies, Semantic web and Bioinformatics, Genome projects - Education and Training - Nano technology in Healthcare - Nanomedicine, Nanopharma, CNT based Nano sensor, BioCom chip, Medical Nanorobo - Virtual **8Hrs**

Design and Development of Hospital Information Systems – Developing front-end, back-end and Client – Server interface programs in Java Environment – SQL. **8Hrs**

INTERNET AND WEB

Medical Networks - Java script programming - Web Design and programming - Design of Web portal services in medicine **8Hrs**

Text Books

1 Robert E Hoyt, Ann Yoshihashi, Health Informatics: Practical Guide for Healthcare and Information Technology Professionals, 6th Edition, lulu.com, 2014.

2 Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005

3 Mohan Bansal M S, Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005.

4 Herbert Schildt, The Complete Reference – JAVA, Tata McGraw Hill Publishing Company, New Delhi, 2005

Reference Books:

1 Yi-Ping Phoebe, Bioinformatics Technologies, Springer International, New Delhi, 2007

2 Orpita Bosu, Bioinformatics – Databases, Tools and Algorithms, Oxford University Press, 2007

3 H M Dietel, Internet and World Wide Web, AB Goldberg publishers, New Delhi, 2007

Online courses:

1. www.bu.edu › BU Online Home › Programs

2. study.com/.../Online_Graduate_Courses_and_Classes_in_Healthcare_Inf...

3. https://www.umb.edu/academics/caps/certificates/healthcare_informatics

E-Books:

1. E-Books: www.springer.com/in/book/9782817804774
2. ebooks.himss.org/product/medical-informatics-executive-primer

Lab Component (Applicable if course is integrated)

Alternate Assessment Test1:- Seminar based on Hospital management systems

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

COURSE TITLE	BIOMATERIALS AND ARTIFICIAL ORGANS	COURSE CODE	22MDBIPEBA
Credits	3	L-T-P	2-1-0

Pre Requisites: Engineering Physics, Engineering Chemistry, Biochemistry

Course Outcomes

CO1	Identify the role of biomaterials in the field of biomedical engineering.
CO2	Apply recent trends of different biomaterials in drug delivery systems
CO3	Comprehend the processes and challenges involved in implants and prosthesis using alloys
CO4	Design various grafts for tissue repair and artificial organs.
CO5	Enumerate biomaterials for implants, soft and hard tissue replacements.

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1		3	
CO2	3		
CO3		3	
CO4			3
CO5			
AVG	3	3	3

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY:

Definition and classification of biomaterials, Mechanical properties, Viscoelasticity, wound healing process, Body response to implants, Biomedical Materials and Biocompatibility. **[8 hours]**

IMPLANT MATERIALS:

Metallic implant materials, Stainless steels, Co based alloys, Ti-based alloys, Ceramic implant materials, Aluminum oxides, Hydroxyapatite, Glass ceramics, Carbons, Medical applications. **[8 hours]**

POLYMERIC IMPLANT MATERIALS:

Polymerization, Polyamides, Acryrilic polymers, Rubbers, High strength thermoplastics, Medical applications, Biopolymers - collagen and elastin; Medical textiles silica, Chitosan, PLA composites, Sutures, Wound dressings; Materials for ophthalmology contact lens, intraocular lens, membranes for plasma separation and blood oxygenation. **[8 hours]**

TISSUE REPLACEMENT IMPLANTS:

Small intestinal submucosa and other decellarized matrix biomaterials for tissue repair; Soft tissue replacements, Sutures, Surgical tapes, Adhesive, Percutaneous and skin implants, Maxillofacial augmentation, Vascular grafts, Hard tissue replacement Implants, Joint replacements, Pancreas replacement. **[8 hours]**

ARTIFICIAL ORGANS:

Artificial blood, Artificial skin, Artificial heart, Prosthetic cardiac valves,

Artificial lung (oxygenator), Artificial kidney (Dialyzer membrane), Artificial pancreas, Dental implants. **[8 hours]**

Text Books

1. Sujata V. Bhatt, "Biomaterials", 2nd edition, Narosa Publishing House, 2005.

2. Joseph D. Bronzino, "The Biomedical Engineering Hand Book - Tissue Engineering and Artificial Organs" , 3rd Edition, CRC Press LLC, Taylor & Francis Group ,2006.

Reference Books:

1. Joon Park, R. S. Lakes, "Biomaterials: An Introduction", 3rd edition, Springer Science & Business Media, 2007.

2. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, "Introduction to Biomedical Engineering", 2nd edition, Elsevier, 2005.

Online courses:

1. https://www.edx.org/learn/biomaterials

2. https://ocw.mit.edu/courses/20-441j-biomaterials-tissue-interactions-fall-2009/

3. https://onlinecourses.nptel.ac.in/noc22_bt61/preview

E-Books:

1. http://www.issp.ac.ru/ebooks/books/open/Biomaterials_Science_and_Engineering.pdf
2. https://www.pdfdrive.com/artificial-organs-e156910986.html

COURSE TITLE	BIOMECHANICS AND REHABILITATION ENGINEERING	COURSE CODE	22MDBIPEBR
Credits	3	L-T-P	2-1-0

Pre Requisites: Engineering Physics

Course Outcomes

CO1	Describe the mechanics of moving systems and competently analyze gross movement of the human body.
CO2	Analyze computationally the dynamics of human movement from the most commonly used measurement devices in the field, such as motion capture (gait) and force platform systems.
CO3	Discuss the design process and working of orthotic and prosthetic devices and mobility aids
CO4	Learn and Demonstrate Design and Modelling of Prosthetic devices ,Submit a report of the same
CO5	Analyse Rehabilitation concept through Field visit ,prsent and document the same.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1		3	
CO2	3		
CO3		3	
CO4			3
CO5			
AVG	3	3	3

Biomechanics Applications to Joint Structure and Function: Introduction to Kinematics; Displacement in space; Force vectors and gravity; Linear forces and concurrent forces; Kinetics of rotary and translatory forces; Classes of levers; Close chain force analysis. **8Hrs**

Joint Structure and Function: Properties of connective tissues; Human Joint design; Joint Function and changes in disease.
Integrated Functions: Kinetics and Kinematics of Postures; Static and Dynamic Postures; Analysis of Standing, Sitting and Lying Postures. **8Hrs**

Gait: Gait cycle and joint motion; Ground reaction forces; Trunk and upper extremity motion; internal and external forces, moments and conventions; Gait measurements and analysis.
Force Platform and Kinematic Analysis: Design of force platforms, Integrating force and Kinematic data; linked segment, free-body analysis. **8Hrs**

Orthotic Devices in Rehabilitation Engineering:
General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Biomechanics of orthoses, merits & demerits of orthotics, Material design consideration in orthotics, Callipers-FO, AFO, KAFO, HKAFO. Spinal Orthosis, Cervical, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbosacro-orthosis, Splints-its functions & types. **8Hrs**

Prosthetic Devices: Introduction, Partial Foot Prostheses- Foot-ankle assembly, Trans femoral Prostheses – Knee unit, Axis system, Friction

Mechanisms, Extension aid, Stabilizers, Socket. Disarticulation Prostheses, Knee Disarticulation Prostheses, Hip Disarticulation Prostheses

Mobility Aids: Walking frames, Parallel bars, Rollators, Quadripods, Tripods & walking sticks, Crutches, Wheel chairs,Case study ,Rehabilitation center field visit. **8Hrs**

Text Books

1. Joint Structure and Function, A Comprehensive Analysis", Pamela K. Levangie and Cynthia C. Norkin, JAYPEE Publications, Fourth Edition, 2006

2. Biomechanics; Mechanical Properties of Living Tissues", Y. C. Fung Springer Verlag, 1985.

3. Rehabilitation Medicine" - By Dr. S. Sunder, 2nd Edition, Jaypee Medical Publications, Reprint 2004.

"Physical Rehabilitation" - by Susan B O'Sullivan, Thomas J Schmitz. 5th Edition, Jaypee Pub.,2007

Reference Books:

1. Biomechanics, Structures and Systems, A. A. Biewener, Sports Publication.

2. Biomechanics of Human Motion, T. McClurg, Anderson.

Online courses:

1. Visual3D 3D Biomechanics: Adwww.c-motion.com/
2. https://rerc-aac.psu.edu/dissemination/webcasts/
3. https://ep.jhu.edu/programs-and-courses/585.414-rehabilitation-engineering

E-Books:

1. https://www.pdfdrive.com/biomechanics-principles-trends-and-applications-biomechanics-theory-and-applications-e184985858.html
2. https://www.pdfdrive.com/the-biomedical-engineering-handbook-third-edition-3-volume-set-biomedical-engineering-fundamentals-the-biomedical-engineering-handbook-fourth-edition-e166007017.html

COURSE TITLE	MACHINE LEARNING	COURSE CODE	22MDBIPEML
Credits	3	L-T-P	2-1-0

Pre Requisites: Linear Algebra and Probability

Course Outcomes

CO1	Formulate any given data-oriented problem as a machine learning and deep learning problem
CO2	To be able to choose and perform the different types of data pre-processing required to clean the data and remove noise.
CO3	To be able to choose and perform the suitable feature extraction and machine learning model on the given data.
CO4	To be able to formulate experiments and analyze the practical performance of the machine learning model for a given task.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2			
CO3	2	2	
CO4		3	3
AVG	3	3	3

Introduction: Overview of the required math, Introduction to Machine Learning, what will be covered in the class, Introduction to python and Scikit-Learn package.

Components of a machine learning project: Working with real data, Get and visualize the data, Prepare the data for machine learning, Select train and fine tune your model. Linear and polynomial regression.

[8 hours]

Classification and SVMClassification: Binary classification, Multi-label classification, Performance measures: confusion matrix, ROC curve.

Support Vector Machines (SVM): Linear SVM classification, Nonlinear SVM classification, SVM regression

Application: Cognitive State detection **[8 hours]**

Decision Trees and KNNDecision Trees: Training and visualizing a decision tree, making predictions, Estimating class probabilities, The CART algorithm k-nearest neighbours (knn), Bias-Variance trade-off and error analysis, Model selection and feature selection

Application: Tumor Type Prediction, Bioinformatics, fMRI data
[8 hours]

Clustering and Dimensionality reductionK-means clustering: Algorithm, Initialization, Getting stuck, K-means for image segmentation.

Application: Gene Expression

Dimensionality reduction: Approaches -- projection and manifold learning, Principal Component Analysis (PCA), Choosing the right number of dimensions, PCA for compression.

Application: drug discovery, EEG analysis **[6 hours]**

Deep LearningDeep Learning (DL) and Neural Networks: Introduction to DL, Neural Network Basics, Different DL architectures and intro to DL frameworks, fully connected Deep Network, Convolutional Neural Network. Evaluating and debugging learning algorithms, Practical advice on structuring an ML project

Application: Medical Imaging, ECG, EEG data [10 hours]

Text Books

1. Theobald, Oliver. Machine learning for absolute beginners: a plain English introduction. Scatterplot press, 2017.

2. Müller, Andreas C., and Sarah Guido. Introduction to machine learning with Python: a guide for data scientists. " O'Reilly Media, Inc.", 2016.

Reference Books:

1. Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras,and TensorFlow. " O'Reilly Media, Inc.", 2022.

Online courses:

1. https://www.simplilearn.com/learn-machine-learning-basics-skillup

2. https://developers.google.com/machine-learning/crash-course

E-Books:

1. https://mml-book.github.io/book/mml-book.pdf

2. https://www.ibm.com/downloads/cas/GB8ZMQZ3

3 https://www.deeplearningbook.org/

Alternate Assessment Test1:- Mini Project implementation

- The project may be very practical in terms of applying techniques you have learned in the course to a real problem such as the classification of disease
- The project may involve designing or adapting existing algorithms to a novel class of For example, how might we solve multiple related classification tasks? How can we improve document clustering by designing a new clustering metric?
- The project may consist of a theoretical analysis of a method we have discussed. For example, this may be in terms of complexity, convergence,
- The project can be a theoretical or more applied survey of a branch of machine learning that we didn't go through in detail. For example, you may write about the use of machine learning in understanding neural systems or sample complexity of machine learning

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

COURSE TITLE	VIRTUAL REALITY	COURSE CODE	22MDBIPEVR
Credits	3	L-T-P	2-1-0

Pre Requisites: Basic concepts of Linear algebra and Probability dsitributions

Course Outcomes

CO1	Understand the fundamental concepts relating to Virtual Reality such as presence, immersion, and engagement
CO2	Able to formulate requirements of 3D virtual environments.
CO3	Ability to formulate requirements of 3D interaction techniques.
CO4	Ability to create simple immersive virtual reality applications.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	**2**		
CO2	**2**		
CO3	**3**		
CO4	**3**		**2**
AVG	**3**		**2**

Introduction Introduction: Definition of VR, modern experiences, historical perspective.

Bird's Eye View: Hardware, sensors, displays, software, virtual world

generator, game engines, human senses, perceptual psychology, psychophysics.

The Geometry of Virtual Worlds: Geometric modeling, transforming rigid bodies, yaw, pitch, roll, axis-angle representation, quaternions, 3D rotation inverses and conversions, homogeneous transforms, transforms to displays, look-at and eye transforms, canonical view and perspective transforms, viewport transforms. **[8 hours]**

Visual Perception and Rendering :

Visual Perception: Depth perception, motion perception, vection, stroboscopic apparent motion, color perception, combining information from multiple cues and senses, implications of perception on VR.

Visual Rendering: Graphical rendering, ray tracing, shading, BRDFs, rasterization, barycentric coordinates, VR rendering problems, anti-aliasing, distortion shading, image warping (time warp), panoramic rendering. **[8 hours]**

Motion and Tracking: Motion in Real and Virtual Worlds: Velocities, acceleration, vestibular system, virtual world physics, simulation, collision detection, avatar motion, vection.

Tracking: Tracking systems, estimating rotation, IMU integration, drift errors, tilt and yaw correction, estimating position, camera-feature detection model, perspective n-point problem, sensor fusion, lighthouse approach, attached bodies, eye tracking, inverse kinematics, map building, SLAM. **[8 hours]**

Interaction and Audio: Interaction: Remapping, locomotion, manipulation, social interaction, specialized interaction mechanisms. Audio: Sound propagation, ear physiology, auditory perception, auditory localization; Fourier analysis; acoustic modeling, HRTFs, rendering, auralization. **[8 hours]**

Evaluating VR and Frontiers: Evaluating VR Systems and Experiences: Perceptual training, recommendations for developers, best practices, VR sickness, experimental methods that involve human subjects.

Frontiers: Touch, haptics, taste, smell, robotic interfaces, telepresence, brain-machine interfaces. **[8 hours]**

Text Books

1 Virtual Reality, Steven M. LaValle. Cambridge University Press 2016

Reference Books:

1 Handbook of Virtual Environments: Design, Implementation, and Applications, Kelly S. Hale and Kay M. Stanney, CRC Press, 2nd Edition, 2015

2 Jerald, Jason. The VR book: Human-centered design for virtual reality. Morgan & Claypool, 2015.

Online courses:

1. https://nptel.ac.in/courses/106106138

E-Books:

1. http://lavalle.pl/vr/book.html

Alternate Assessment Test1:- what are students supposed to do and how it will be evaluated when they should submit/ when it will be evaluated Mini Project implementation: **Implementation of VR environment in Unity or Unreal development software**

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

COURSE TITLE	BIOMETRICS	COURSE CODE	22MDBIOEBM
Credits	3	L-T-P	3-0-0

Pre Requisites: Algorithmic approach, Engineering Mathematics.

Course Outcomes

CO1	Ability to apply knowledge of mathematics, science and engineering to understand the concepts of Biometrics.
CO2	Ability to analyse and select a methodology of Biometrics.
CO3	Ability to interpret Biometric concepts & analysis to be used in relevant application.
CO4	Implement the concept for certain identified application, document and present the same.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	**3**		
CO2		**3**	
CO3	**2**		
CO4			
AVG	**3**	**3**	

INTRODUCTION

Person Recognition, Biometric Systems, Enrolment and recognition phases, Sensor module, Feature extraction module, Database module, Matching

module, Biometric Functionalities, Verification, Identification, Biometric System Errors, Performance measures, The Design Cycle of Biometric Systems, Nature of the application, Choice of biometric trait, Data collection, Choice of features and matching algorithm, Evaluation, Applications of Biometric Systems, Security and Privacy Issues. **[8 hours]**

FINGERPRINT RECOGNITION:
Introduction, Friction Ridge Pattern, Features, Formation, Fingerprint Acquisition, Sensing techniques Image quality, Feature Extraction, Ridge orientation and frequency estimation, Singularity extraction, Ridge extraction, Minutiae extraction, Matching, Alignment , Pairing minutiae, Match score generation, Latent fingerprint matching, Fingerprint individuality, Performance evaluation Fingerprint Indexing, Fingerprint Synthesis, Level 1 feature synthesis, Level 2 feature synthesis, Palm print, Palm print features Palm print recognition in forensics, Palm print recognition for access control. **[8 hours]**

FACE RECOGNITION: Introduction, Psychology of face recognition, Facial features, Design of a face recognition system, Image Acquisition, 2D Sensors 3D Sensors, Video sequences, Face Detection, Viola-Jones face detector, Feature Extraction and Matching, Appearance-based face recognition, Model-based face recognition, Texture-based face recognition, Performance evaluation, Advanced Topics, Handling pose, illumination, and expression variations , Heterogeneous face recognition , Contents xv, Face modelling. **[8 hours]**

IRIS RECOGNITION:Introduction, Design of an Iris Recognition System, Image Acquisition, Iris Segmentation, Segmentation using the integro-differential operator, Segmentation using Geodesic Active Contours (GAC), Generating iris masks, Iris Normalization, Iris Encoding and Matching, Iris Quality & assessment techniques, Performance Evaluation. **[8 hours]**

MULTIBIOMETRICS, SECURITY SYSTREMS: Introduction, Ear detection, Ear recognition, Challenges in ear recognition, Gait, Feature extraction and matching, Challenges in gait recognition, Hand Geometry, Image capture, Hand segmentation, Feature Extraction, Feature matching, Challenges in hand geometry recognition, Soft Biometrics, Sources of Multiple Evidence, Acquisition and Processing Architecture, Fusion Levels, Adversary Attacks, Insider attacks, Infrastructure attacks, Attacks at the User Interface, Impersonation, Obfuscation, Spoofing, Countermeasure: spoof detection, Attacks on Biometric Processing, Attacks on the system modules, Attacks at the interconnections, Attacks on the Template Database, Countermeasure: biometric template security. **[8 hours]**

Text Books

1. Introduction to Biometrics by Anil K. Jain, Arun A. Ross, Karthik Nandakumar. Springer Publications.

Reference Books:

1. Biometrics- The Ultimate Reference- John D. Woodward, Jr. Wiley Dreamtech.

2. Personal Identification in Networked Society, Jain, A.K.; R Bolle, Ruud M.; S Pankanti, Sharath, 1st ed. 1999. 2nd printing, 2006, Springer Publications

Online courses:

1. https://nptel.ac.in/courses/106/104/106104119/

2. https://www.coursera.org/lecture/usable-security/biometric-authentication-RXVog

E-Books:

1. https://b-ok.asia/book/1227683/10281d

2. https://b-ok.asia/book/646924/950bf5?dsource=recommend

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

COURSE TITLE	INDUSTRY 4.0	COURSE CODE	22MDBIOEI4
Credits	3	L-T-P	3-0-0

Pre Requisites: NILs

Course Outcomes

CO1	Describe Industry 4.0 and scope for Indian Industry
CO2	Demonstrate conceptual framework and road map of Industry 4.0
CO3	Describe Robotic technology for Industry 4.0
CO4	Demonstrate obstacle and framework conditions for Industry 4.0

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	1		
CO2	1		
CO3	3		
CO4	2		2
AVG	2		2

Introduction to Industry 4.0: Introduction, core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0

[7 hours]

A Conceptual Framework for Industry 4.0: Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0. **[7 hours]**

Technology Roadmap for Industry 4.0: Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase. **[8 hours]**

Advances in Robotics in the Era of Industry 4.0: Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly **[8 hours]**

Obstacles and Framework Conditions for Industry 4.0: Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data **[10 hours]**

Text Books

1. Ustundag, Alp, and Emre Cevikcan. Industry 4.0: managing the digital transformation. Springer, 2017.

Reference Books:

1. Bartodziej, Christoph Jan. "The concept industry 4.0." In The concept industry 4.0, pp. 27-50. Springer Gabler, Wiesbaden, 2017.

2. Schwab, Klaus. The fourth industrial revolution. Currency, 2017.

Online courses:

1. https://www.edx.org/course/industry-40-how-to-revolutionize-your-business
2. https://nptel.ac.in/courses/106105195

E-Books:

1. https://library.oapen.org/bitstream/handle/20.500.12657/43836/external_content.pdf?sequence=1

Alternate Assessment Test1:-

Assignment

- Evolution of Industry 4.0 and predicting Industry 5.0

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

COURSE TITLE	MINI PROJECT	COURSE CODE	22MDBIPWMP
Credits	2	L-T-P	0-0-2

Course Outcomes

CO1	Implement algorithms, and / or techniques that contribute to the Hardware/ Software solution of the project
CO2	Analyse and interpret experimental results/Test and validate the conformance of the developed prototype against the original requirements of the problem.
CO3	Engage in effective communication is through presentation of project work, prepare technical reports and paper publication.
CO4	Demonstrate the standards/norms/ethical practices during implementing the solution

Course Outcomes	PO1	PO2	PO3
CO1	**3**		**3**
CO2	**3**		**3**
CO3		**3**	
CO4	**3**		
AVG	**3**	**3**	**3**

Course Outcomes

Guidelines for Mini Project

1. The students should interact with doctor, biomedical engineer or paramedical technician during Clinical Immersion in 1st semester to understand their problems or foresee what can be undertaken for study in the form of research/testing/projects, and for creative and innovative methods to solve the identified problem.
2. Medical Device development (hardware or software as a device) to be developed based on need based analysis/ problem definition through clinical immersion
3. Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.
4. Students will present progress presentations and give demo for the evaluation
5. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department.
6. The CIE marks will be awarded based on the evaluation of demo, Project Report, Project Presentation skills and Question and Answer session
7. SEE (University examination) shall be as per the University norms.

COURSE TITLE	PYTHON PROGRAMMING FOR BIOMEDICAL ENGINEERING	COURSE CODE	22MDBIAEPP
Credits	2	L-T-P	0-0-2

Pre Requisites: Computer Concepts and C Programming

Course Outcomes

CO1	Interpret the fundamental of Python syntax and be fluent in the use of Python control flow statements.
CO2	Express proficiency in the handling of strings, functions and lists.
CO3	Learn methods to create and manipulate Python programs by utilizing the data structures like dictionaries, tuples and sets
CO4	Recognize the commonly used operations involving file systems.
CO5	Analyze data science operation and plot various Bio signal using Pandas and Numpy library for Matplotlib..

CO-PO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2		3	
CO3			3
CO4	3		
CO5			
AVG	3	3	3

Getting Started With Python : Overview of Software development, Programming languages, Python and thrust areas of Python, Python Installation and Google Colab.

Introduction to Python Programming: Need for programming, Keywords and Identifiers, statements and expressions, comments, variables, Data types and type conversion, Input and Output, Operators, Precedence and Associativity, Indentation.

Control Flow Statements: If else decision control flow, for loop, while loop, continue and break statements, pass keyword, nested statements.

[6 hours]

Lists: Creating Lists, Basic List Operations, Indexing and Slicing in Lists, List Methods

String: Creating and Storing Strings, Basic String Operations, Accessing Characters in

String by Index Number, String Slicing and Joining, String Methods, Formatting Strings

Functions: Definition and calling the function, Function arguments, Command Line Arguments, return statement, scope and lifetime of variables, recursion, Built in functions, commonly used modules and packages, sorting, binary search **[6 hours]**

Tuples and Sets: Creating Tuples, Basic Tuple Operations, Indexing and Slicing in

Tuples, Relation between Tuples and Lists, Tuple Methods, Sets, Set Methods, Traversing of Sets, frozenset ()

Dictionaries: Creating Dictionary, Relation between Tuples and

Dictionaries, Accessing and Modifying key value Pairs in Dictionaries, Dictionary Methods **[6 hours]**

Files: Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, The Pickle Module, Reading and Writing CSV Files, Python os and os.path Modules **[6 hours]**

Introduction to Data science: NumPy and Pandas with Python, Graphs with Matplotlib pyplot: Line Graphs, Scatter Graph, Pie Charts, Bar Charts, Figures and Subplot, 3D Graphs Case Study: Bio-Signal Plotting using Matplotlib/Pandas Library

Probability distribution- Poison and Normal distributions, Least square Curve Fitting, Correlation and Regression lines Statistical methods and Tests for data analysis Optimizations Algorithms. **[6 hours]**

Text Books

1 Martin C. Brown, "Python: The Complete Reference", McGraw Hill Education; Fourth edition, 2018
2 Mark Summerfield, "Programming in Python
3 A Complete Introduction to the Python Language", Pearson Education

Reference Books:

1 Zed A. Shaw, "Learn Python The Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code, 3rd edition" , Adisson-Wesley

2 Erik Westra, "Modular Programming with Python: introducing modular techniques for building sophisticated programs using Python", Packt Publishing

Online courses:

1 https://docs.spyder-ide.org/current/index.html
2 https://wiki.python.org/moin/BeginnersGuide
3. https://www.programiz.com/python-programming

E-Books:

1. https://www.syncfusion.com/succinctly-free-ebooks/python
2. https://jakevdp.github.io/PythonDataScienceHandbook/?utm_source=devfreebooks&utm_medium=medium&utm_campaign=DevFreeBooks

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

COURSE TITLE	Embedded Systems	COURSE CODE	20MDBIPEES
Credits	3	L-T-P	2-1-0

Pre Requisites: Knowledge of Microcontrollers, basic electronic hardware and programming

Course Outcomes:- At the end of the course, students will have the ability to

CO1	Independently design and develop embedded systems for sensing and processing real world signals
CO2	Comprehend and analyze an embedded system, write a report and present it.
CO3	Demonstrate a degree of mastery in the embedded system design, development and evaluation

CO-PO mapping:

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2		3	
CO3			3
AVG	3	3	3

Introduction:- Embedded System Components, Characteristics, and quality attributes, Glue logic. Platform-based design methodology, Hardware in the loop, Sensors for the real world, Sample and hold circuits, ADCs – Successive approximation, Pipelined. Quantization noise. Embedded Processing: Energy, Code-size and execution-time efficiency.

8 Hrs

Embedded System Hardware:- Core : DSP, Microcontrollers, VLIW, Multicore, GPUs, SoCs, Reconfigurable logic. Memories-Conflicting goals, Hierarchies, Reference files, Caches. Communication: Requirements, Electrical robustness, Guaranteed Real Time behavior, Examples – CAN and I2C. Securing hardware. **8 Hrs**

Embedded Firmware design: - Design approaches, Development languages and design – Low and high level language based approaches, Mixing assembly with high level. RTOS: RT Kernel, Tasks, Processes and threads and thread standards, Multitasking, - types, Task communication and synchronization, Overview of mechanisms. **8 Hrs**

Embedded System Software:- General requirements, Task communication and synchronization, Resource access protocols, Priority – Inversion, inheritance, and ceiling protocol. Stack resource policy, Enterprise real-time kernel – ERIKA. Embedded Linux-overview. Selection of RTOS. **8 Hrs**

Evaluation and Validation:- Scope, Multi-objective Optimization, Relevant objectives. Performance evaluation – Early phases, WCET estimation, Real Time Calculus. Quality metrics: Approximate computing, simple criteria of quality, criteria for data analysis, worst case energy consumption. Dependability and safety analysis. **8 Hrs**

Text Books

1. Peter Marwedel, Embedded System Design, 3rd edition, 2018, Springer
2. Shibu K.V, Introduction to Embedded systems, 2nd edition, 2017, McGraw Hill.

Reference Books:

1. Jack Ganssle, The art of designing embedded systems, 2nd edition, 2008, Newness, Elsevier,
2.James K Peckol, Embedded systems, 1st edition, 2008, Wiley

Online courses:

1.https://www.coursera.org/learn/embedded-software-hardware
2.https://onlinecourses.nptel.ac.in/noc20_ee98/preview
3.https://www.edx.org/course/embedded-systems-shape-the-world-multi-threaded-in

E-Books:

1. http://users.ece.utexas.edu/~valvano/Volume1/E-Book/
2. http://freecomputerbooks.com/Embedded-System-Design.html

Alternate Assessment Test1:- Presentation on a case study of Medical embedded system design

COURSE TITLE	HEALTH CARE DATA ANALYTICS	COURSE CODE	22MDBIPEDA
Credits	3	L-T-P	2-1-0

Pre Requisites: There are no pre-requisites for this course.

Course Outcomes

CO1	Discuss the role of data analytics in quality and performance efforts.
CO2	Describe the tools and techniques used for data analytics in health care organizations.
CO3	Identify techniques to communicate insights gained from data analysis.
CO4	Prepare, analyze, interpret, evaluate, and present clinical and operational data for the purposes of improving outcomes (quality, effectiveness, efficiency, safety) in the current healthcare job market.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2			
CO3			
CO4	3		
AVG	3		

Healthcare Data Acquisition and Management: Types and sources of healthcare data, along with methods for selecting, preparing, querying and

transforming healthcare data. Participants examine the range of data sources, including administrative, clinical, patient-reported, and external data (e.g., CCDs, HL-7 messages); common representations of data in health information systems (ICD-10, CPT); strategies for optimizing data quality; querying tools and methods including data preparation and transformation techniques. **[8 hours]**

Applied Statistics for Healthcare Analytics: Basic health statistics primer (as refresher); mortality, morbidity, and risk adjustment; cost effectiveness analysis; and methods for evaluating population variation. **[8 hours]**

Quantitative Methods in Healthcare Management: Forecasting techniques using trends analysis and linear regression; geographic-based service assessments; quality control in healthcare systems; tools for identifying quality problems; and the use of simulation methods. We look at a widely used open-source,web-based health statistical system District Health Information Software v2 (DHIS2) and its use of BI tools to visualize health data. **[8 hours]**

Data Mining for Healthcare Analytics: Application of data mining techniques for purposes of big data analytics, using administrative and clinical systems data. Topics include an overview of the data mining process, data mining standards and output protocols, and common techniques used in mining healthcare data. **[8 hours]**

New Trends in Healthcare Services: Value-driven healthcare system, measuring health system performance, existing quality/performance

measurement frameworks (HEDIS),existing Analytics maturity model (DELTA), comparing healthcare delivery, and attributes of high performing healthcare systems. **[8 hours]**

Text Books

1 Analytics at Work: Smarter Decisions, Better Results by Thomas H. Davenport, Harris, J. G., & Morison R, Harvard Business Review Press (February 8, 2010) , ISBN: 978-1422177693

2 Data Analysis with R by Tony Fischetti, 1st Edition (December 22, 2015) Packt Publishing

Reference Books:

1 Ott, R Lyman, and Michael T Longnecker. An Introduction to Statistical Methods & Data Analysis,7th Edition. Cengage. ISBN 978-1305269477

2 Trevor L. Strome (2013). Healthcare Analytics for Quality and Performance Improvement. John Wiley & Sons, Inc.

Online courses:

1 https://vatraining.remote-learner. net/ mod/ page/ view. php? id=18438

2 https://www.edx.org/course/data-analytics-and-visualization-in-health-care

E-Books:

1. https://ebooks.iospress.nl/volume/health-informatics-meets-ehealth-digital-insight-information-driven-health-care-proceedings-of-the-11th-ehealth2017-conference

2. https://ebooks.iospress.nl/volume/data-protection-and-confidentiality-in-health-informatics

COURSE TITLE	PHOTONICS FOR MEDICAL IMAGING	COURSE CODE	22MDBIPEPM
Credits	3	L-T-P	2-1-0

Course Outcomes: After completion of this course the student will be able to:

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.
CO4	Know the photonics instruments , optical properties of tissue , diagnostic applications of lasers in medical fields, aplication of therapeutic and surgical applications of lasers in medical fields, fiber optic sensors used In medical application.
CO5	Utilize optical components for microscopes in biomedical imaging with simulation research studies with a research analysis report.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2			
CO3	3		
CO4		3	3
CO5	3		3
AVG	3	3	3

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.

[8 hours]

Bio-imaging: Principles and Techniques: An Overview of Optical Imaging, Transmission Microscopy, Simple Microscope, Compound Microscope, Kohler Illumination,NumericalAperture Resolution.and **[8 hours]**

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 Tuneable 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 **[8hours]**

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 **[8 hours]**

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 **[8 hours]**

Text Books

1 Introduction to Bio-photonics, Paras N Prasad, A John Wiley & Sons, Inc., Publication. 2003.

Reference Books:

1 Fundamentals of Light Microscopy & Electronic Imaging, Douglas B Murphy, John Wiley & Sons, 2001

2 Biomedical Optics: Principles and Imaging, Lihong V Wang, Hsin-I Wu, May 2007

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

COURSE TITLE	PROJECT WORK PHASE-1	COURSE CODE	22MDBIPWP1
Credits	10	L-T-P	0-0-10

Course Outcomes

CO1	Implement algorithms, and / or techniques that contribute to the Hardware/ Software solution of the project
CO2	Analyse and interpret experimental results/Test and validate the conformance of the developed prototype against the original requirements of the problem.
CO3	Engage in effective communication is through presentation of project work, prepare technical reports and paper publication.
CO4	Demonstrate the standards/norms/ethical practices during implementing the solution

Course Outcomes	PO1	PO2	PO3
CO1	**3**		**3**
CO2	**3**		**3**
CO3		**3**	
CO4	**3**		
AVG	**3**	**3**	**3**

Guidelines:

1. The students should interact with doctor, biomedical engineer or paramedical technician or industry during to establish the problem definition for the project work.
2. Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.
3. In detail Literature review and partial implementation (40%) to be completed in Project Phase-1.
4. Students will present progress presentations and give demo for the evaluation
5. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department.
6. The CIE marks will be awarded based on the evaluation of demo, Project Report, Project Presentation skills and Question and Answer session

SEE (University examination) shall be as per the University norms.

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

COURSE TITLE	INTERNSHIP	COURSE CODE	22MDBIINT1
Credits	3	L-T-P	0-0-3

Course Outcomes

CO1	Apply domain knowledge in proposing solution for problems in the Healthcare Domain and work in collaboration/ multidisciplinary environment
CO2	work independently and develop/implement the design with appropriate techniques, resources and contemporary tools and deliver solution with stipulated planning
CO3	Prepare the technical report on the work carried out during the internship

Course Outcomes	PO1	PO2	PO3
CO1	3		3
CO2	3		3
CO3		3	
AVG	3	3	3

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

Guidelines for Internship:

1. All the students will have to undergo mandatory internship in III semester and in IV semester. This internship Period is minimum 4-6 weeks.
2. Students are expected report their mentor weekly to give updates on internship work.
3. For Continuous Internal Evaluation (CIE), three progress presentations will be conducted during III and IV semester to evaluate the student performance in the industry.
4. Students will present their work in consultation with their Guide in industry. Finally report will be prepared at the end of 4^{th} semester. Students will include the internship certificate in the IV semester report.
5. SEE for internship in III and IV semesters will be conducted in presence of internal Guide/Mentor and industry Guide or external examiner.
6. Students will present the work done during the internship. Marks will be allocated based on presentation, viva voce and report.

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

COURSE TITLE	MOOC ON BMSPI/ALLIED	COURSE CODE	22MDBINC01
CREDITS	NCMC	L-T-P	----

Guidelines for MOOC:

students will register for the MOOC related to BMSPI or allied areas only
The MOOC must be of 4 weeks or 8 weeks duration
After completion of the course students will submit certificate
Based on the certificate P/NP grade will be given

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

COURSE TITLE	SKILL ENHANCEMENT COURSE ON DEEP LEARNING	COURSE CODE	22MDBINC02
Credits	NCMC	L-T-P	----

Guidelines for Skill Enhancement Course on Deep Learning:

students will register for the Skill Enhancement Course on Deep Learning
This course can be completed either in online mode or offline mode during any of the semesters during the program
The course duration can be 1 to 4 week or more than this.
After completion of the course students will submit certificate
Based on the certificate P/NP grade will be given

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

COURSE TITLE	TELEMEDICINE	COURSE CODE	22MDBIPETM
Credits	3	L-T-P	2-1-0

Course Outcomes

CO1	To teach the key principles for telemedicine and health.
CO2	Introduce the students with the knowledge of telemedical standards
CO3	Design and develop m-Health platforms for telemedical applications

Telemedicine and Telehealth: History and Evolution of telemedicine, Purposes and its organization, Medical assistance of remote patients: Problems and Potentialities Lessons from maritime Telemedicine, Teleconsultation, Tele health, Organs of Telemedicine, Global and Indian scenario, Advances in Telemedicine, Benefits and Challenges Telehealth Protocols and Procedure **[8 hours]**

Telemedical Technology :Principles of Multimedia: Text, Audio, Video, data - Data communications and networks, Internet, Body centric wireless communication: Wireless Body Area Networks (WBAN), Wireless Sensor Networks (WSN) and Wireless Personal Area Networks (WPAN) and their design concepts Antenna design considerations for in-body and on-body electronics - Communication infrastructure for Telemedicine - Telemedicine through world wide web (WWW). **[8 hours]**

Telemedical Standards: Real-time Telemedicine integrating doctors / Hospitals, Access to health care services – Health education and self-care, Telesurgery, Teleradiology, Telecardiology, Teleoncology, Telemedicine in neurosciences, Telepathology, Business aspects - Project planning and costing, Usage of telemedicine. Telemedicine and in loco assistance of patients, Interactive videoconferencing consults, Store and forward consults, Remote monitoring and home care, Home **[8 hours]**

m-Health and Telemedicine Mobile Devices : Smart phones, Tablet PCs, iPads, PDAs, Wearable computers – m-Health technology and communication infrastructure - Healthcare Apps – m-Health applications: Education and awareness, Remote data collection, Remote monitoring, Communication and training for healthcare workers, Disease and epidemic outbreak tracking, Diagnostic and treatment support – m-Health and the Transformation of Clinical Trials - Harnessing data, advanced analytics, and the Internet of Things to optimize digitized clinical trials **[8 hours]**

Security and Legal Issues : International regulations in e-health and telemedicine, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Informed consent in Telemedicine, Data Security and Standards, security and confidentially of medical records and access control, TCP/IP, ISO-OSI, DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Cyber laws related to telemedicine. Patient Rights

[8 hours]

Text Books

1. Wootton, R., Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006
2. David Dagan Feng, Biomedical Information Technology, Academic Press Series in Biomedical Engineering, Elsevier Inc, USA, 2008

Reference Books:

1 3. Ilias G. Maglogiannis, Kostas Karpouzis and Manolis Wallace, Image and Signal Processing for Networked E-Health Applications, Morgan & Claypool Publishers' series, USA, 2006

COURSE TITLE	NEUROIMAGING AND BRAIN MAPPING	COURSE CODE	22MDBIPENI
Credits	3	L-T-P	2-1-0

Pre Requisites: There are no pre-requisites for this course.

Course Outcomes

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.
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.
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.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1			
CO2	3		
CO3			
CO4	3		
AVG	3		

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. **[8 hours]**

Neuroimaging Techniques: Functional and structural neuroimaging methodology of neuroimaging techniques of MRI, fMRI, PET and EEG/ERP, highlighting their relative strengths and limitations. **[8 hours]**

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. **[8 hours]**

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. **[8 hours]**

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. **[8 hours]**

Text Books

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 edited by William D. Penny, Karl J. Friston, John T. Ashburner, Stefan J. Kiebel, Thomas E. Nichols

3 Neuroradiology: The Requisites (Requisites in Radiology) 4th Edition by Rohini Nadgir MD (Author), David M. Yousem MD MBA (Author)

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

COURSE TITLE	HOSPITAL MANAGEMENT	COURSE CODE	22MDBIPEHM
Credits	3	L-T-P	2-1-0

Pre Requisites: Nil

Course Outcomes

CO1	Ability to define healthcare management and differentiate among the functions, roles, and responsibilities of health care managers
CO2	Ability to explore on International and national healthcare problems and issues
CO3	Develop skills in applying the concepts to address real-life issues in hospital management

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3
CO1	3		
CO2		3	
CO3			3
AVG	3	3	3

An Overview of Health Care Management : Introduction, The Need For Managers And Their Perspectives, Management: Definition,

Functions, And Competencies, Management Positions: The Control In The Organizational Hierarchy, Focus Of Management: Self, Unit/Team, Challenges in Hospital Administration – Hospital Planning – Equipment Planning – Functional Planning - Current Issues in Hospital Management - Telemedicine - Bio-Medical Waste Management. **[8 hours]**

Healthcare Industry:

An Introduction, A Global View, The India Scenario, Health and National Economy, Health System Performance. **[8 hours]**

Overview of Health Care Sector in India:

An Introduction, Health Financing, Health Infrastructure, Human Resources in Health, Role of Hospitals in the Health Sector. **[8 hours]**

Hospital Management Functions:

An Introduction, Operations Management, Finance and Cost Management, HR Management, Materials Management, **[8 hours]**

Hospital Management Support Systems:

An Introduction, Clinical Support, Information Support: Hospital MIS, Administrative Support Systems. **[8 hours]**

Text Books

1K.V. Ramani, "Hospital Management Text and Cases", 1st edition Pearson Education, Dorling Kindersley (India) Pvt. Ltd., 2013

2R N, Sharon B. Buchbinder, Nancy H. Shanks, "Introduction to Health Care Management" , Third edition, y Jones & Bartlett Learning, LLC, an Ascend Learning Company2017.

Reference Books:

1Peter Zweifel · Friedrich Breyer · Mathias Kifmann, "Health Economics", Second Edition, Springer Dordrecht Heidelberg London New York.

2Edda Weimann, Peter Weimann, "High Performance in Hospital Management: A Guideline for Developing and Developed Countries", 1st edition, Springer-Verlag Berlin Heidelberg, 2017.

Online courses:

1 https://www.coursera.org/learn/healthcare-marketplace?specialization=healthcare-marketplace

2. https://www.coursera.org/learn/healthcare-delivery-providers?specialization=healthcare-marketplace

3. https://www.coursera.org/learn/healthcare-medical-technology?specialization=healthcare-marketplace

E-Books:

1. https://www.academia.edu/38166165/Healthcare_and_Hospital_Management_Edited_book_Exce

2. https://www.ebooksread.com/authors-eng/sante-roberti/hospital-management-goo-983.shtml

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

COURSE TITLE	PROJECT WORK PHASE-2	COURSE CODE	22MDBIPWP2
Credits	10	L-T-P	0-0-10

Course Outcomes

CO1	Implement algorithms, and / or techniques that contribute to the Hardware/ Software solution of the project
CO2	Analyse and interpret experimental results/Test and validate the conformance of the developed prototype against the original requirements of the problem.
CO3	Engage in effective communication is through presentation of project work, prepare technical reports and paper publication.
CO4	Demonstrate the standards/norms/ethical practices during implementing the solution

Course Outcomes	PO1	PO2	PO3
CO1	**3**		**3**
CO2	**3**		**3**
CO3		**3**	
CO4	**3**		
AVG	**3**	**3**	**3**

Guidelines:

1. The students should interact with doctor, biomedical engineer or paramedical technician or industry during to establish the problem definition for the project work.
2. Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.
3. In detail Literature review and partial implementation (40%) to be completed in Project Phase-1.
4. Students will present progress presentations and give demo for the evaluation
5. CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department.
6. The CIE marks will be awarded based on the evaluation of demo, Project Report, Project Presentation skills and Question and Answer session
7. SEE (University examination) shall be as per the University norms.

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

COURSE TITLE	INTERNSHIP	COURSE CODE	22MDBIINT2
Credits	3	L-T-P	0-0-3

Course Outcomes

CO1	Apply domain knowledge in proposing solution for problems in the Healthcare Domain and work in collaboration/ multidisciplinary environment
CO2	work independently and develop/implement the design with appropriate techniques, resources and contemporary tools and deliver solution with stipulated planning
CO3	Prepare the technical report on the work carried out during the internship

Course Outcomes	PO1	PO2	PO3
CO1	3		3
CO2	3		3
CO3		3	
AVG	3	3	3

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

Guidelines for Internship:

1. All the students will have to undergo mandatory internship in III semester and in IV semester. This internship Period is minimum 4-6 weeks.
2. Students are expected report their mentor weekly to give updates on internship work.
3. For Continuous Internal Evaluation (CIE), three progress presentations will be conducted during III and IV semester to evaluate the student performance in the industry.
4. Students will present their work in consultation with their Guide in industry. Finally report will be prepared at the end of 4th semester. Students will include the internship certificate in the IV semester report.
5. SEE for internship in III and IV semesters will be conducted in presence of internal Guide/Mentor and industry Guide or external examiner.
6. Students will present the work done during the internship. Marks will be allocated based on presentation, viva voce and report.

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

COURSE TITLE	MOOC ON BMSPI/ALLIED	COURSE CODE	22MDBINC03
Credits	NCMC	L-T-P	—

Guidelines for MOOC:

1. students will register for the MOOC related to BMSPI or allied areas only
2. The MOOC must be of 4 weeks or 8 weeks duration
3. After completion of the course students will submit certificate
4. Based on the certificate P/NP grade will be given

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

COURSE TITLE	PEDAGOGY STUDIES	COURSE CODE	22MDBINC04
Credits	NCMC	L-T-P	----

Guidelines for Pedagogy Studies Course:

The objective is to introduce students to pedagogical knowledge in science technology, engineering, and mathematics (STEM) disciplines.
This course can be completed either in online mode or offline mode during any of the semesters during the program
The course duration can be 1 to 4 week or more than this.
After completion of the course students will submit certificate
Based on the certificate P/NP grade will be given