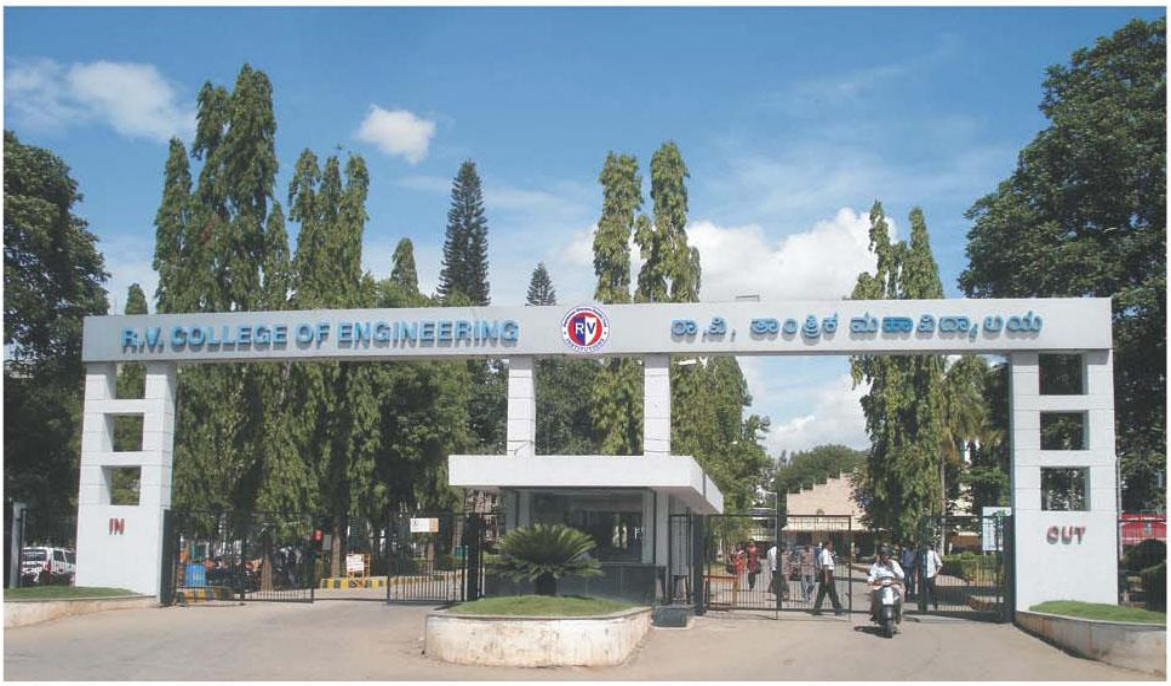
RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysuru Road
Bengaluru – 560 059



Scheme and Syllabus of I to IV Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
BIO MEDICAL SIGNAL PROCESSING
&
INSTRUMENTATION

DEPARTMENT OF
ELECTRONICS & INSTRUMENTATION ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work and Innovation

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Scheme and Syllabus of I to IV Semesters
(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
BIO MEDICAL SIGNAL PROCESSING
&
INSTRUMENTATION

DEPARTMENT OF
ELECTRONICS & INSTRUMENTATION ENGINEERING

Department of Electronics & Instrumentation Engineering

Vision

Achieving academic excellence in Instrumentation Technology by adopting interdisciplinary research with a focus on sustainable and inclusive technologies.

Mission

- To create an environment for students to excel in domain areas and get motivated to involve in interdisciplinary research by utilizing state of the art infrastructure.
- To impart technical knowledge, encourage experiential learning and develop future professional leaders.
- To establish industry-academia networking and develop industry-ready students and future entrepreneurs, to meet societal & industrial challenges.
- To motivate lifelong learning and research in sustainable technologies to find improved solutions for the betterment of society.

M. Tech. in Biomedical Signal Processing & Instrumentation Program graduates will be able to:

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

PO2 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 specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4 Develop innovative techniques for health care applications using modern engineering hardware, and software simulation tools.

PO5 Adapt interdisciplinary research leading to successful biomedical professionals, with an aptitude for life-long learning.

PO6 Practice intellectual integrity, ethical research, and become capable of developing functional prototypes worth the patenting and technology transfer

Program Specific Criteria for M.Tech in Biomedical Signal Processing & Instrumentation

Professional Bodies: Bio Medical Engineering Society of India

The M.Tech in Biomedical Signal Processing &Instrumentationcurriculum is designed to enable the students to (a) The applications of biomedical sciences to develop, test, operate, and maintain biomedical equipment(b The ability to analyze, design, and implement biomedical engineering systems(c) The ability to utilize statistics, transform methods, discrete mathematics and applied differential equations in support of biomedical signal and image processing.(d) An understanding of the clinical applications of biomedical equipments..

ABBREVIATIONS

Sl. No.	Abbreviation	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Signal Processing &Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

CONTENTS

RV COLLEGE OF ENGINEERNG®, BENGALURU-560 059
(Autonomous Institution Affiliated to VTU, Belagavi)

DEPARTMENT OF ELECTRONICS & INSTRUMENTATION ENGINEERING

M.Tech Program in BIO MEDICAL SIGNAL PROCESSING & INSTRUMENTATION

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MBS11	Mathematics For Bio Medical Signal Processing	EI	3	1	0	4
2	18MBS12	Medical Physiology & Instrumentation	EI	4	0	1	5
3	18MBS13	Bio MEMS& NEMS	EI	4	0	1	5
4	18HSS14	Professional Skill development	HSS	0	0	0	0
5	18MBS1AX	Elective Group-A	EI	4	0	0	4
6	18MBS1BX	Elective Group-B	EI	3	1	0	4
Total number of Credits				**18**	**2**	**2**	**22**
Total Number of Hours / Week				**18**	**4**	**4**	**26**

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MBS21	Medical Image Processing	EI	3	1	1	5
2	18MBS22	Bio Medical Sensors & Data Acquisition	EI	3	1	0	4
3	18IM23	Research Methodology	IEM	3	0	0	3
4	18MBS24	Minor Project	EI	0	0	2	2
5	18MBS2CX	Elective Group-C	EI	4	0	0	4
6	18MBS2DX	Elective Group-D	EI	4	0	0	4
7	18MBS2GX	Global Elective Group-G	R.BoS	3	0	0	3
Total number of Credits				**20**	**2**	**3**	**25**
Total Number of Hours / Week				**20**	**4**	**6**	**30**

SEMESTER : I		
GROUP A: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MBS1A1	Embedded Controller
2.	18MBS1A2	Wireless Technologies for medical Applications
3.	18MBS1A3	Healthcare and Hospital Management
GROUP B: PROFESSIONAL ELECTIVES		
1.	18MBS1B1	OOPS with Java
2.	18MBS1B2	Python Programming
3.	18MBS1B3	Bioinformatics & programming
SEMESTER : II		
GROUP C: PROFESSIONAL ELECTIVES		
1.	18MBS2C1	Bio statistics
2.	18MC2C2	Machine Learning
3.	18MBS2C3	Biomechanics
GROUP D: PROFESSIONAL ELECTIVES		
1.	18MBS2D1	Lasers in medicine
2.	18MBS2D2	IoT for Healthcare
3.	18MBS2D3	Basics of orthopaedics, Medicine& Ethics

GROUP G: GLOBAL ELECTIVES				
Sl. No.	**Dept**	**Course Code**	**Course Title**	**Credits**
1.	CS	18CS2G01	Business Analytics	3
2.	CV	18CV2G02	Industrial & Occupational Health and Safety	3
3.	IM	18IM2G03	Modelling using Linear Programming	3
4.	IM	18IM2G04	Project Management	3
5.	CH	18CH2G05	Energy Management	3
6.	ME	18ME2G06	Industry 4.0	3
7.	ME	18ME2G07	Advanced Materials	3
8.	CY	18CH2G08	Composite Materials Science and Engineering	3
9.	PY	18PH2G09	Physics of Materials	3
10.	MA	18MT2G10	Advanced Statistical Methods	3

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MBS31	Medical Imaging and Techniques	EI	4	1	0	**5**
2	18MBS32	Internship	EI	0	0	5	**5**
3	18MBS33	Major Project : Phase I	EI	0	0	5	**5**
4	18MBS3EX	Professional Elective-E	EI	4	0	0	**4**
Total number of Credits				**8**	**1**	**10**	**19**
Total Number of Hours/Week				**8**	**2**	**20**	**30**

SEMESTER : III		
GROUP E: PROFESSIONALELECTIVES		
Sl. No.	**Course Code**	**Course Title**
4.	18MBS3E1	Artificial Organs & Bio Materials
5.	18MBS3E2	Rehabilitation Engineering
6.	18MBS3E3	Ergonomics

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MBS41	Major Project : Phase II	EI	0	0	20	**20**
2	18MBS42	Technical Seminar	EI	0	0	2	**2**
Total number of Credits				**0**	**0**	**22**	**22**
Total Number of Hours / Week				**0**	**0**	**44**	**44**

SEMESTER : I					
MATHEMATICS FOR BIO MEDICAL SIGNAL PROCESSING (Theory)					
Course Code	**:**	**18MBS11**		**CIE Marks**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**3Hrs**

Unit-I	**08 Hrs**
Introduction to discrete time analysis: Definitions of discrete time signals and Linear Time invariant system, introduction to frequency domain representation of Discrete-time signals. Convolution, Correlation, Introduction to DFT and its relationship with other transform (Fourier and Z). DFT properties.Direct computation of DFT, Need for efficient computation of DFT (FFT Algorithms). Radix-2 FFT algorithm for the computation of DFT and IDFT – decimation in time and decimation in frequency algorithms	
Unit – II	**08 Hrs**
FIR Filter Design: Introduction to FIR filters, Design of FIR filters using Hamming, Rectangular, Bartlet window method, FIR filter design using frequency mapping method. **IIR Filter Design:** Design of IIR filters from analog filters (Butterworth and Chebyshev). Impulse invariance method and bilinear transformation methods	
Unit -III	**08Hrs**
ECG: ECG signal origin, ECG parameters-QRS detection different techniques, ST segment analysis. **Signal averaging:** Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software and limitations of signal averaging. **Adaptive Filtering:** Introduction, General structure of adaptive filters, LMS adaptive filter, adaptive noise cancellation, Cancellation of 60 Hz interference in ECG, Cancellation of maternal ECG in fetal ECG.	
Unit –IV	**08 Hrs**
Frequency Domain Analysis: Introduction, Spectral analysis, linear filtering, cepstral analysis and homomorphic filtering. Removal of high frequency noise (power line interference), motion artifacts (low frequency) and power line interference in ECG. **Time Series Analysis:** Introduction, AR models, Estimation of AR parameters by method of least squares and Durbin's algorithm, ARMA models.Spectral modeling and analysis of PCG signals.	
Unit –V	**07 Hrs**
Spectral Estimation: Introduction, Blackman-tukey method, The periodogram, Pisarenko's Harmonic decomposition, Prony' method, Evaluation of prosthetic heart valves using PSD Techniques, Comparison of the PSD estimation methods.	
Tutorial	
Tutorial Class Topics: 1) Acquisition and Display of Biomedical Signals. 2) Display of Noised ECG Signal and Its Filtering. 3) A) Realization of Low pass Integer Filter. B) Realization of High pass Integer Filter C) Realization of Band pass Integer Filter 4) Design of Fir Notch Filter. 5) A) Realization of IIR One-Pole Filter B) Realization of IIR Two-Pole Low pass Filter C) Realization of IIR Two-Pole High pass Filter D) Realization of IIR Two-Pole Band pass Filter E) Realization of IIR Two-Pole Band Reject Filter 6) PSD Using Periodgram Technique And Computation Of FFT 7) Compression of ECG Using Turning Point Algorithm 8) QRS Detection and Heart Rate Measurement.	

9) Plotting of ECG Spectrum With 60 Hz Noise Using FFT 10) ECG Signal Averaging Using Delayed Samples. 11) Problems on FIR Filter Design. 12) Problems on IIR Filter Design. Discussion and Analysis of Time domain and Frequency domain signals.	
Course Outcomes **After completing the course, the students will be able to:**	
CO1	Understand the basic concepts (mathematics & Signal processing) and tools for real time Processing of signals.
CO2	Analyze signal processing of physiological signals through digital signal processing techniquesto address biomedical problems.
CO3	Apply DSP techniques to solve complex problems related to biomedical domain.
CO4	Evaluate and develop the effectiveness of techniques applied to biomedical signals against Specific benchmarks.
Reference Books	
1	Digital Signal Processing: Principles, Algorithms and Applications, John G.Proakis, Dimitris G. Manolakis, 3rd Edition, 2012, PHI Pvt Ltd, ISBN: 978-1-111-42737-5.
2	Biomedical Signal Processing Time and Frequency Domains Analysis (Volume I), Arnon Cohen, Edition, 1986, CRC press, ISBN: 978-1-111-42737-5.
3	Biomedical Signal Processing Principles and Techniques, D.C.Reddy, Edition, 2012.Tata McGraw-Hill, ISBN: 978-1-111-42737-5.
4	Biomedical Digital Signal Processing, Willis J. Tompkins, edition, 2000, PHI, ISBN: 978-1-111-42737-5.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I					
MEDICAL PHYSIOLOGY AND INSTRUMENTATION (Theory & Practice)					
Course Code	**:**	**18MBS12**		**CIE Marks**	**100+50**
Credits L:T:P	**:**	**4:0:1**		**SEE Marks**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**3 +3 Hrs**

Unit-I	**10 Hrs**

General Physiology: Cell, Cell junctions, Transport through cell membrane.Bio-Electric Potentials. Introduction to Medical Instrumentation System and General constraints in design of Medical instruments

Respiratory System & Environmental Physiology: Physiological anatomy of respiratory tract, Pulmonary circulation, Mechanics of respiration, Ventilation, Exchange of respiratory gases, Transport of respiratory gases, Regulation of respiration. Pulmonary function tests; Lung volume and Capacity, Basic Spirometer, Ultrasonic Spirometer, Measurement of residual volume by Nitrogen wash out Method.

Unit – II	**11 Hrs**

Renal Physiology: Kidney, Nephron, Juxtaglomerular apparatus, Urine formation, Concentration of urine, Acidification of urine, Renal function tests.

Artificial Kidney; Principle and Hemodialysis Machine.

Cardiovascular System: Introduction to cardiovascular system, Properties of cardiac muscle, Cardiac cycle& heart sounds, Pace-Makers External Pacemaker, Implantable Pacemaker, Cardiac output, Arterial blood pressure & its Measurement

Unit -III	**11 Hrs**

GIS: GIS, Functions of stomach, pancreas, liver, intestine, function tests: Endoscopies.

Nervous System: Introduction to nervous system, Neuron, Classification of nerve fibers, Properties of nerve fibers, Degeneration & regeneration of nerve fibers, Neuroglia, Receptors, Synapse, Neurotransmitters, Reflex activity, cerebrospinal fluid, Cerebral circulation and tests. Electroencephalogram

Unit –IV	**10 Hrs**

Muscle Physiology: Classification of muscles, Structure of skeletal muscles, Properties of skeletal muscles, Changes during muscular contraction, Neuromuscular junction. Electro-Myograms.(EMG)

Hemopoietic System: Body fluids, Blood, Plasma, Proteins, Anaemia, Blood-Group, Blood Transfusion. Blood Flow Meters.

Endocrine system: Introduction to Endocrine System, Thyroid gland, Pituitary gland

Unit –V	**10 Hrs**

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

LABORATORY EXPERIMENTS	**2 Hrs/Week**

Analyze the acquired bio signals from the following equipment, Compare the same with standard normal values and interpret the signals.

1. Electrocardiogram and determine the cardiac vector.
2. EMG biofeedback system with nerve conduction velocity.
3. Audiogram and determine the percentage of hearing.
4. Air conduction thresholds testing using audiometer.
5. Phonocardiograph
6. LAB-VIEW & its Bio-Medical Applications
7. Analysis of Lung function tests using Spirometry.

8. Perform an experiment on acquisition of PPG and Realization of a Pacemaker circuit. 9. Observe and record heart sound using Electronic stethoscope.	
Course Outcomes: **After completing the course, the students will be able to:**	
CO1	Understand human physiology at a cellular, tissue, and organ systems level and biomedical instrumentation.
CO2	Analyze the integration and control of different physiological systems and their roles in maintaining homeostasis
CO3	Develop basic knowledge about working of human body and the physiological parameters associated with them.
CO4	Apply the knowledge of human physiology & instrumentation to develop Bio-medical instrumentation systems.
Reference Books	
1	Essentials of Medical Physiology, K Sembulingam&PremaSembulingam, 6thEdition, 2013, Jaypee Publications, ISBN:978-93-5025-936-8.
2	Concise Medical Physiology, Sujit K. Chaudhuri , 6thRevised Edition, 2011 , New Central Book Agency Pvt. Ltd,ISBN-13: 978-8173811395.
3	Human Physiology, Chaterjee',11th Edition Volume one and Two, 2016 , CBS Publications ISBN 978-81-239-2873-9/978-81-239-2872-2
4	Handbook of Biomedical Instrumentation, R. S. Khandpur,3rd Edition, 2011,Tata McGraw-Hill, ISBN: 9780070473553

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: I					
BIO-MEMS AND NEMS (Theory & Practice)					
Course Code	**:**	**18MBS13**		**CIE Marks:**	**100+50**
Credits L:T:P	**:**	**4:0:1**		**SEE Marks:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration:**	**3 + 3 Hrs**

Unit-I	**10 Hrs**
Over view of MEMS& Microsystems and Working Principles of Microsystems: MEMS and Microsystems, Typical MEMS and Microsystem Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystem Design and Manufacture, Applications of Microsystems in Automotive, Health Care, Aerospace and other Industries. Working Principle of Microsystems: Microsensors: Acoustic, Chemical, Optical, Pressure, Thermal and Biomedical & Biosensors. Microactuation: Using Thermal forces, Shape Memory alloys, Piezoelectric Crystals and Electrostatic forces. MEMS with Microactuators: Microgrippers, Micromotors, Microvalves and Micropumps.	
Unit – II	**10 Hrs**
Scaling Laws in Miniaturization, Materials for MEMS and Microsystems: Introduction to Scaling, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces and Scaling in Fluid Mechanics. Substrates and Wafers, Active Substrate Materials, Silicon as a Substrate Material, Single silicon Crystal, Silicon Compounds, Silicon Piezoresistors, Galium Arsenide, Quartz, Piezoelectric Crystals, Polymers and Packaging Materials.	
Unit -III	**11 Hrs**
NANO Fabrication Processes: Introduction to Nano Fabrication Process, Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapor Deposition (CVD), Physical Vapor Deposition-Sputtering, Deposition by Epitaxy, Etching, The LIGA Process: General Description of LIGA Process, Materials for Substrates and Photoresists, Electroplating and SLIGA Process, MEMs Packaging Techniques.	
Unit –IV	**11 Hrs**
Introduction to BioMEMS, Microactuators and Drug Delivery: What are BioMEMS, the Driving force behind Biomedical Applications, Biocompatibility, Reliability Considerations Regulatory Considerations, Activation Methods, Microactuators for Microfluidics, Equivalent Representation, Drug Delivery, Introduction to Clinical Laboratory Medicine, Chemistry, Hematology, Immunology, Microbiology, Urinalysis, Coagulation Assays, Arterial Blood gases.	
Unit –V	**10 Hrs**
Micro-Total-Analysis Systems (μTAS): Lab-on-Chip, Capillary Electrophoresis Arrays (CEA), Cell, Molecule and Particle Handling, Surface Modification Microspheres, Cell Based Bioassay Systems. Introduction to Emerging BioMEMs Technology, Minimally Invasive Surgery, Point-of-care Clinical Diagnosis, Cardiovascular, Diabetes, Endoscopy, Neurosciences, Oncology Ophthalmology, Dermabrasion, Tissue Engineering, Cell based Biosensors.	
LABORATORY EXPERIMENTS	**2 Hrs/Week**
Simulation Experiments: Simulation of different types of Sensors and actuators Using Comsol Multiphysics.	

Course Outcomes:
After completing the course, the students will be able to:

CO1	Describe the fundamentals of micro technology and nanotechnology, especially those related to bioengineering.
CO2	Explain the main bioengineering-related techniques and processes of micro and nanotechnology.
CO3	Apply micro and nanotechnology to fabricate P micro-bio devices and nano devices for biomedical applications.
CO4	Adapt the acquired knowledge to Bio engineering field and develop Bio-MEMS devices.

Reference Books	
1	MEMS and Microsystems, Design & Manufacture, Tai Ran Hsu, ,2008, John Wiley& Sons Publications, ISBN: 9780470083017.
2	Fundamentals of BioMEMS and Medical Microdevices, Steven S. Saliterman, 1st Edition, CENGAGE Learning, India ISBN-13: 978-0819459770.
3	Smart Material Systems and MEMS-Design and Development Methodologies, Vijay K. Vardan, K.J.Vinoy, S. Gopalakrishnan, , 2011,WILEY INDIA, ISBN: 978-81-265-3170-7
4	Micro and Smart Systems, G.K. Ananthasuresh, K.J. Vinoy, S.Gopalakrishnan, K.N. Bhat, V.K. Aatre, Reprint: 2014,WI LEY INDIA Edition, ISBN: 978-81-265-2715-1

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Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: I						
PROFESSIONAL SKILL DEVELOPMENT (Common to all Programs)						
Course Code	**:**	**18HSS14**		**CIE Marks**	**:**	**50**
Credits L: T: P	**:**	**0:0:0**		**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**24 L**				

Unit – I	**03 Hrs**
Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis. **Resume Writing:** Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.	
Unit – II	**08 Hrs**
Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc.Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities. **Reasoning** – a. **Verbal** - Blood Relation, Sense of Direction, Arithmetic & Alphabet. b. **Non- Verbal reasoning** - Visual Sequence, Visual analogy and classification. **Analytical Reasoning** - Single & Multiple comparisons, Linear Sequencing. **Logical Aptitude** - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions. **Verbal Analogies/Aptitude** – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving	
Unit – III	**03 Hrs**
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews	
Unit – IV	**03 Hrs**
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion(Assertiveness) and presentation skills	
Unit – V	**07 Hrs**
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited). **Leadership Skills:** Ethics and Integrity, Goal Setting, leadership ability.	

Course Outcomes

After going through this course the student will be able to:

CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

Reference Books

1.	The 7 Habits of Highly Effective People, Stephen R Covey, 2004 Edition, Free Press, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie, 1st Edition, 2016, General Press, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book, 2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Scheme of Continuous Internal Examination (CIE) Evaluation of CIE will be carried out in TWO Phases.	
Phase	**Activity**
I	After the completion of Unit 1 and Unit 2, students are required to undergo a test set for a total of 50 marks. The structure of the test will have two parts. Part A will be quiz based, evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
II	Students will have to take up second test after the completion Unit 3, Unit 4 and Unit 5. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
FINAL CIE COMPUTATION	
Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. The attendance will be same as other courses.	

SEMESTER: I					
EMBEDDED CONTROLLER (Professional Elective-A1)					
Course Code	**:**	**18MBS1A1**		**CIE Marks:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks:**	**100**
Hours:	**:**	**52L**		**SEE Duration:**	**3Hrs**

Unit-I	**10 Hrs**
Motivation for advanced microcontrollers – Low Power embedded systems, On-chip peripherals, low-power RF capabilities. Examples of applications. **Embedded Electronic Systems and Microcontrollers :** What Are Embedded Systems, Approaches to Embedded Systems , Small Microcontrollers, Anatomy of a Typical Small Microcontroller **MSP430 RISC CPU architecture:** Compiler-friendly features, Clock system, Memory subsystem. Key differentiating factors between different MSP430 families, Understanding the muxing scheme of the MSP430 pins	
Unit – II	**10 Hrs**
Functions, Interrupts and Low Power modes:Functions and subroutines, Interrupts, Low Power modes of operation. **Digital I/O** –Digital Input and Output: Parallel ports, programming examples.	
Unit -III	**11 Hrs**
Development for Programming MSP430: Development Environment, **Instruction** set, The, Assembly Language /C programming, Access to the Microcontroller for Programming and Debugging	
Unit –IV	**11 Hrs**
On-chip peripherals: Watchdog Timer, Comparator, Op-Amp, Basic Timer, ADC, DAC, SD16	
Unit –V	**10 Hrs**
Case Studies and Applications: Security Applications , Wireless Sensor Networking, Low-Power RF circuits and Pulse Width Modulation (PWM) in Power Supplies **Biomedical Applications**: :Design Considerations ,Blood Pressure Monitors ,blood Glucose and Other Diagnostic Meters ,Asset Security/Authentication .Patient Monitoring ,Electrocardiogram (ECG)/ Portable ECG and Electroencephalogram (EEG), Pulse Oximeter	

Course Outcomes

After completing the course, the students will be able to:

CO1	Understand fundamentals of embedded controllers.
CO2	Apply the programming concepts to develop an application.
CO3	Analyze and compare the application developed with embedded controllers.
CO4	Develop real time applications using any practical controllers.

Reference Books

1	MSP430 Microcontroller Basics, John .H. Davies,2nd Edition,2008, Elsevier Publications, ISBN: 978-0-7506-8276-3.
2	The 8051 and MSP430 Microcontrollers, K. Uma Rao, Dr. AndhePallavi, 1st Edition,2012, Elsevier Publications, ISBN: 9789381269459
3	Embedded Systems Design using TI MSP430, Chris Nagy, 1st Edition, 2003, Elsevier Publications,ISBN:978-0-7506-7623-6
4	Online Course materials from: *www.ti.com* › TI University Program www.ti.com/healthtechguides

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I					
WIRELESS TECHNOLOGIES FOR MEDICAL APPLICATIONS (Professional Elective-A2)					
Course Code	**:**	**18MBS1A2**		**CIE Marks**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**100**
Hours	**:**	**52L**		**SEE Duration**	**3Hrs**
Unit-I					**10 Hrs**
Fundamentals of Wireless Communication: Digital Communications, Wireless Communication System, Wireless Media, Frequency Spectrum, Technologies in Digital wireless Communication, Coding, Types of Wireless Communication Systems**.**					
Unit – II					**10 Hrs**
Wireless Body Area Network (WBAN): Network Architecture, Network Components, Design Issues, Network Protocols, WBAN Technologies, WBAN Applications					
Unit -III					**11 Hrs**
Wireless Personal Area Networks: Wireless Personal Area Network (WPAN) , Network Architecture, WPAN Components, WPAN Technologies and Protocols, WPAN Applications					
Unit –IV					**11 Hrs**
Wireless Local Area Networks: Network Components, Design Requirements of WLAN, Network Architecture, WLAN Standards,Case studies in biomedical domain					
Unit –V					**10 Hrs**
Applications of Wireless Sensor Networks: Introduction, Background Examples of Category of WSN Applications Home Control, Building Automation, Industrial Automation, Medical Applications, Case studies in biomedical domain					
Course Outcomes **After completing the course, the students will be able to:**					
CO1	Understand the fundamentals of wireless technologies involved in health domain application.				
CO2	Apply advanced wireless technologies for biomedical applications.				
CO3	Analyze sensor network techniques for the hospital management.				
CO4	Evaluate the impact of the technology on society, and relate this to global issues, governmental issues and economics				
Reference Books					
1	Wireless and Mobile Networks, Concepts and Protocols, Sunilkumar S. Manvi ,Mahabaleshwar S. Kakkasageri,2nd Edition, 2016,Wiley Publications,ISBN-13: 978-8126520695.				
2	Fundamentals of Wireless Sensor Networks: Theory and Practice,WaltenegusDargie, Christian Poellabauer, Willey Publications, ISBN-13: 978-8126551255				
3	Wireless Communications & Networks, William Stallin, 2nd Edition, 2004,Pearson, ISBN 978-8132231561.				
4	Wireless Communication – Principles &Practice, T.S. Rappaport ,Pearson, 2nd Edition, 2010, Pearson Publications, ISBN-13: 978-8131731864.				

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I					
HEALTHCARE AND HOSPITAL MANAGEMENT (Professional Elective-A3)					
Course Code	**:**	**18MBS1A3**		**CIE Marks**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**100**
Hours	**:**	**52L**		**SEE Duration**	**3Hrs**
Unit-I					**10 Hrs**
Forms Of Organization: Sole proprietorship, Partnership, Company-public and private sector enterprises, Principles of management, Evolution of management					
Unit – II					**10 Hrs**
Principle Of Hospital Management: Importance of management and Hospital, Management control systems. Forecasting techniques decision-making process.					
Unit -III					**11 Hrs**
Staffing: Staffing pattern in hospitals, Selection, Recruiting process, Training of staff, Organizational structures, Career development					
Unit –IV					**11 Hrs**
Marketing And Management: Basic concepts marketing, Principles of social marketing, Social marketing in health sector, Consumer behavior and research health, Advertising in Health Sector, Relevance of e-marketing of Health care services					
Unit –V					**10 Hrs**
Computer In Hospital: System Development life cycle, Reasons to use computers in hospital, main categories of information systems in hospitals					
Course Outcomes **After completing the course, the students will be able to:**					
CO1	Understanding the principles of hospital management				
CO2	Apply the practices essential for managing a hospital organization.				
CO3	Analyze and compare the practices essential for managing a hospital organization.				
CO4	Develop solutions at the interdisciplinary level related to strategic and Operative Management of hospitals.				
Reference Books					
1	Human Resource Management in Hospital, Goyal R.C., 7th Edition, 2017, Prentice Hall of India Pvt. Ltd., New Delhi, ISBN: 978-81-203-5365-7.				
2	Management & systems, Nauhria R.N. and Rajnish Prakash, 1995, New Delhi Wheeler publishing, ISBN*:* 979-605-925-8.				
3	Essentials of Management, Harold Koontz, 8th edition, 2013, Mc Graw Hill, ISBN*:* 9780070356122				
4	Introduction To Health Care Management,Sharon Bell Buchbinder, Nancy H. Shanks, Inc, 3rd Revised edition, 2013, Jones and Bartlett Publishers, ISBN-13: 978-1284081015				

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I					
OOPS WITH JAVA (Professional Elective-B1)					
Course Code	**:**	**18MBS1B1**		**CIE Marks**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**3Hrs**

Unit-I	**07 Hrs**
The Java Programming Environment: Installing the Java Development Kit, Using the Command-Line Tools, Using an Integrated Development Environment, Running a Graphical Application, Building and Running Applets. **Fundamental Programming Structures in Java:** A Simple Java Program, Comments, Data Types, Variables, Operators, Strings, Input and Output, Control Flow, Arrays.	
Unit – II	**08 Hrs**
Objects and Classes: Introduction to Object-Oriented Programming, Using Predefined Classes, Defining Your Own Classes, Static Fields and Methods, Method Parameters, Object Construction, Packages, The Class Path, Documentation Comments, Class Design Hints. **Inheritance:** Classes, Super classes, and Subclasses, The Cosmic Superclass, Generic Array Lists, Object Wrappers and Auto boxing, Methods with a Variable Number of Parameters, Enumeration Classes, Reflection, Design Hints for Inheritance	
Unit -III	**08 Hrs**
Interfaces, Lambda Expressions, and Inner Classes: Interfaces, Lambda Expressions, Inner Classes, Proxies. **Multi-Threaded Programming, Event Handling:** Multi-Threaded Programming: What are threads? How to make the classes thread able, Extending threads, Implementing runnable, Synchronization, Changing state of the thread, Bounded buffer problems, read-write problem, producer-consumer problems.	
Unit –IV	**08 Hrs**
Exceptions, Assertions, and Logging: Dealing with Errors, Catching Exceptions, Tips for Using Exceptions, Using Assertions, Logging, Debugging Tips. **Collections:** The Java Collections Framework, Concrete Collections, Maps, Views and Wrappers, Algorithms, Legacy Collections.	
Unit –V	**08 Hrs**
Event Handling: Basics of Event Handling, Actions, Mouse Events, The AWT Event Hierarchy. **User Interface Components with Swing**: Swing and the Model-View-Controller Design Pattern, introduction to Layout Management, Text Input, Choice Components, Menus, Sophisticated Layout Management, Dialog Boxes, Troubleshooting GUI Programs.	

Course Outcomes **After completing the course, the students will be able to:**	
CO1	Understand the basic concepts of JAVA language
CO2	Apply the knowledge of coding for various applications.
CO3	Analyze the implemented code to compare the various concepts of Java programming.
CO4	Design and model the real time application using Java programming.

Reference Books	
1	Core Java, Horstmann, Cay S, 10th Edition, Prentice Hall, 2016, ISBN: 9780134177304.
2	Java The Complete Reference, Herbert Schildt, 8th Edition, Tata McGraw Hill, 2011, ISBN: 978-0-07-160631-8.
3	Java 9 Recipes - A Problem-Solution Approach, Josh Juneau, 3rd Edition, Apress, 2017, ISBN:978-1-4842-1975-1, 978-1-4842-1976-8.
4	Introduction to JAVA Programming, Y. Daniel Liang, 6th Edition, Pearson Education, 2007. ISBN: 0132130807

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I					
PYTHON PROGRAMMING (Professional Elective-B2)					
Course Code	**:**	**18MBS1B2**		**CIE Marks**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**3Hrs**

Unit-I	**07 Hrs**
Getting Started with Python: - Why should you learn to write programs in python. **Program development using IDLE.** – Interacting with the Python shell, creating and editing programs in IDLE. **Data and Expressions:** Literals, Variables, Operators, Data types	
Unit – II	**08 Hrs**
Control Structures: Selection Control, Iterative Control **Strings:**len(), looping and counting, in operator, string methods, parsing, strings, lists and strings. **Lists:** definition, common list operations, list traversal, nested lists, iterating over lists using for and range(), while and lists, assigning and copying lists, list comprehensions.	
Unit -III	**08 Hrs**
Tuples: – creating, accessing elements, slicing, changing or deleting a tuple, membership test, basic tuple operations – concatenation, repetition, built In tuple functions, advantages over lists **Dictionaries:** creating a dictionary, accessing values, updating, deleting, operations in dictionary-traversal, membership, built-in dictionary methods	
Unit –IV	**08 Hrs**
Files: using text files – opening, reading, writing, file positioning, deleting a file. **Functions:** Definition, Keyword arguments, default arguments and positional arguments, variable scope	
Unit –V	**08 Hrs**
Object-Oriented Programming:- Classes and Objects , Classes and functions, Classes and methods CGI programming, Database Access , Networking	

Course Outcomes

After completing the course, the students will be able to:

CO1:	Understand the fundamentals of python programming.
CO2:	Apply the concepts of data structures in Python programming
CO3:	Analyze Object-Oriented Programming as used in Python.
CO4:	Develop an application using python with suitable libraries.

Reference Books

1	Introduction to Computer Science Using Python, Charles Dierbach, illustrated Edition, 2013, John Wiley & Sons, ISBN: 0470555157.
2	Python for Everybody: Exploring Data Using Python 3, Charles R. Severance, 1st Edition, 2016, Create Space Independent Publishing Platform, ISBN: 1530051126
3	Think Python: How to Think Like a Computer Scientist", Allen B. Downey, 2nd Edition, 2015, Green Tea Press, ISBN: 0521898110 .
4	Introduction to Programming Using Python, Y. DanielLiang, Illustrated Edition, 2013, Pearson Publications, ISBN:0132747189

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I					
BIOINFORMATICS & PROGRAMMING (Professional Elective-B3)					
Course Code	**:**	**18MBS1B3**		**CIE Marks**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**3Hrs**

Unit-I	**07 Hrs**
Bioinformatics: Introduction, Objectives of Bioinformatics, What kind of Data is used, Major Bioinformatics databases, Applications of Bioinformatics. **The Central Dogma:** Watson's definition, information flow, from data to knowledge, Convergence, the organization of DNA, the organization of Proteins.	
Unit – II	**08 Hrs**
Perl (BIOPERL) for Bioinformatics: Representing sequence data, program to store a DNA sequence, concatenating DNA fragments, Transcription, Calculating the reverse complement in Perl, Proteins, files, reading proteins in files, Arrays, Flow control, finding motifs, counting Nucleotides, exploding strings into arrays, operating on strings, Reading from and writing to files.	
Unit -III	**08 Hrs**
Designing a Biological Databases: **MySQL:** Creating and Selecting Database, Creating a table, Loading Data into Table, Retrieving information from table **Introduction to PHP**	
Unit –IV	**08 Hrs**
Sequence Alignment Algorithms: Biological motivations of sequence analysis, the models for sequence analysis and their biological motivation, global alignment, local alignment, End free-space alignment and gap penalty, Sequence Analysis tools and techniques.	
Unit –V	**08 Hrs**
Phylogenetic Analysis: Introduction, methods of Phylogenetic analysis, distance methods, the neighbor- Joining (NJ) method, The Fitch/ Margoliash method, character-based methods, Other methods, Tree evaluation and problems in phylogenetic analysis.	

Course Outcomes
After completing the course, the students will be able to:

CO1	Understand the relationship of molecular biology and bioinformatics to computer science
CO2	Apply the Perl, Php and MySql programming to bioinformatics applications
CO3	Analyze the biomedical databases, Alignment and phylogenetic techniques.
CO4	Create the databases for bioinformatics applications and evaluate various alignment and phylogenetic techniques

Reference Books

1	Bioinformatics Methods and Applications, S.C.Rastogi, N. Mendiratta& Parag Rastogi, 4th Edition, 2013, PHI Learning Pvt.Ltd, ISBN: 978-81-203-4785-4.
2	XML for Bioinformatics, Ethan Cerami, 1stEdition , 2005, Springer, ISBN: 0-387-23028-9.
3	Beginning Perl for Bioinformatics, James D. Tisdall , 1st Edition , 2003, O'reilly, ISBN: 0-596-00080-4.
4	Bioinformatics Computing, Bryan Bergeron, M.D, 1stEdition , 2003, Pearson Education Inc, ISBN: 0-13-100825-0.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II					
MEDICAL IMAGE PROCESSING (Theory & Practice)					
Course Code	**:**	**18MBS21**		**CIE Marks**	**100+50**
Credits L:T:P	**:**	**3:1:1**		**SEE Marks**	**100+50**
Hours	**:**	**39L+26T+26P**		**SEE Duration**	**3 + 3 Hrs**

Unit-I	**07 Hrs**
Fundamentals: Introduction, Fundamental steps in DIP, A simple image formation model, representing digital images, Spatial &Gray level resolution, Basic relationship between pixels. **Image Enhancement:** Point operations, Spatial averaging, Median filtering, Spatial low Pass, high pass and band pass filtering, Histogram equalization, Transform operations, Application discussion on Biomedical Digital Image Processing.	
Unit – II	**08 Hrs**
Image Segmentation: Detection of discontinuities, Edge linking and Boundary detection by local processing & global processing using Hough transform, Region based segmentation, Application discussion on Biomedical Digital Image Processing.	
Unit -III	**08 Hrs**
Morphological Image Processing : Basic concepts of set theory, Logical operations involving binary images, Dilation and erosion, Opening and closing, The hit-or-miss transformation, Basic morphological algorithms.	
Unit –IV	**08 Hrs**
Image Representation and Description: Representation – Chain codes, polygonal approximations, signatures, boundary segments, skeletons, Boundary descriptors – Some simple descriptors, Shape numbers, Fourier descriptors, statistical moments, Regional descriptors – Some simple descriptors, topological descriptors, texture.	
Unit –V	**08 Hrs**
Image Compression: Huffman coding, DFT, DCT, Wavelet coding & JPEG standard, Application discussion on Biomedical Digital Image Processing.	
LABARATORY EXPERIMENTS	**2 Hrs/Week**

Perform different image processing experiments as listed below by using MATLAB/SCILAB/PYTON.

1. Medical Image enhancement –Histogram based.
2. Medical Image enhancement – by varying gray levels.
3. Medical Image smoothing.
4. Medical Image sharpening.
5. Algorithm for low pass filter, high pass filter, median filter.
6. Point detection, Line detection, Edge detection (Masks operations).
7. Medical Image Segmentation (Water shed segmentation, Fuzzy k means clustering).
8. Medical Image Restoration.
9. Applications of Wavelets in Medical Image Processing.
10. Assignment on real medical image problem.

Course Outcomes
After completing the course, the students will be able to:

CO1	Understand the fundamentals of Digital image processing including the topics of filtering, transforms, morphology, image analysis and compression
CO2	Evaluate algorithms for image analysis based on segmentation, shape & texture, registration, recognition and classification
CO3	Analyze the different image processing algorithms of segmentation, registration, object recognition and classification using MATLAB
CO4	Develop the necessary skill base to explore and implement Digital Image Processing algorithms.

Reference Books	
1	Digital Image Processing, Rafael C. Gonzalez & Richard E. Woods, 4th Edition,2018,Pearson Education Inc, ISBN-13: 978-0133356724,ISBN-10:9780133356724.
2	Fundamentals of Digital Image Processing, Anil K. Jain, 1stEdition,2010 , Prentice Hall of India, ISBN 13: 9780133361650.
3	Image Processing, Analysis and Machine Vision, MilanSonka, Vaclav Hlavac& Roger Boyle,4th Edition,2015,Cengage Learning US,,ISBN-13: 9781133593607.
4	Practical Algorithms for Image Analysis, Description, Examples & Codes, Michael Seul, Lawrence O'Gorman, Michael J.Sammon, 2nd Edition, 2008,Cambridge University Press

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: II					
BIO MEDICAL SENSORS & DATA ACQUISITION (Theory)					
Course Code	**:**	**18MBS22**		**CIE Marks**	**100**
Credits L:T:P	**:**	**3:1:0**		**SEE Marks**	**100**
Hours	**:**	**39L+26T**		**SEE Duration**	**3Hrs**

Unit-I	**07 Hrs**
Introduction to sensors & Transducers-, Classification of transducers - Resistive, Capacitive, Inductive, Photoelectric, piezoelectric and mechano electronics. Transducers for biomedical applications: Force and pressure transducers: such as piezoelectric, strain gauge, Transducer used for heart sound measurement: microphone, Ultrasonic measurement: properties of ultrasound, ultrasonic transducers, Transducers for respiration rate measurement	
Unit – II	**08 Hrs**
Biological Sensors: Introduction to wearable medical devices and bio-sensing technologies.Design of on-body and in-body biosensors.Communication topologies, protocols, standards and media of body sensor networks (BSN).Usages and roles of BSN in real-life applications.Selected issues in state-of-the-art development of BSN, e.g. information security, signal interference, energy scavenging, multi-sensor fusion and context-aware sensing.	
Unit -III	**08 Hrs**
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 Jellies and Creams, Microelectrodes. **Biomedical Recorders:** ECG leads, effects of artifacts, single channel, multi-channel, ECG ma Vectorcardiograph, Phonocardiograph-microphones and amplifiers for PCG, Electroencephalograph-diagram, computerized analysis of EEG, biofeedback instrumentation. **Patient Monitoring Systems &Oximeters:** Bedside monitors Oximetry, pulse oximeter, skin reflectance oximeter and intravascular oximeter.	
Unit –IV	**08 Hrs**
Fundamentals of Virtual Instrumentation Programming: Introduction to LabVIEW, Components of LabVIEW, Context Help, Creating Sub-VIs. FOR Loop, WHILE Loop, shift registers and feedback nodes, timing function. CASE structures, formula node, Arrays and clusters, visual display types- graphs and charts, File Formats,File I/O Functions, Path Functions,String Functions, LabVIEW String Formats, Typical examples	
Unit –V	**08 Hrs**
Data Acquisition and Case studies: Introduction, Measurement and Automation Explorer, DAQ Assistants, Analysis Assistants.Biomedical toolkit- ECG signal acquisition & feature extraction, EEG simulation, EMG power analysis. Image acquisition and processing. **Case Studies:**myRiO, myDAQ	

Course Outcomes

After completing the course, the students will be able to:

CO1	Understand the fundamentals of sensors, transducer and virtual programming
CO2	Apply the concepts of sensors and instrumentation to acquire the real time signal using LabVIEW
CO3	Analyze the performance characteristics of sensor, transducers output in LabVIEW tool.
CO4	Design and Develop a real time application using Virtual instrumentation and DAQ cards

Reference Books

1	Handbook of Biosensors and Electronic Noses: Medicine, Food and the Environment, Erika Kress-Rogers, 1st Edition, 1996, CRC-Press; ISBN: 0849389054
2	Medical Instrumentation: Application and Design, John G Webster, 3rd Edition, 2008, Willey India Ptv. Ltd, ISBN: 978-81-265-1106-8.
3	Virtual instrumentation Using LabVIEW, JovithaJerome , 4th Edition, 2010, PHI Learning Pvt.Ltd., ISBN:978-8120340305.
4	Handbook of Biomedical Instrumentation, R. S. Khandpur, 3rd Edition, 2011, Tata Mc Graw-Hill , ISBN: 9780070473553.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II					
RESEARCH METHODOLOGY (Common to all programs)					
Course Code	**:**	**18IM23**		**CIE Marks**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**100**
Hours	**:**	**39L**		**SEE Duration**	**3 Hrs**

Unit – I	**08 Hrs**
Overview of Research: Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial	
Unit – II	**08 Hrs**
Data and data collection: Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules. **Sampling Methods:** Probability sampling and Non-probability sampling	
Unit – III	**08 Hrs**
Processing and analysis of Data: Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools	
Unit – IV	**08 Hrs**
Advanced statistical analyses: Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.	
Unit-V	**07 Hrs**
Essentials of Report writing and Ethical issues: Significance of Report Writing ,Different Steps in Writing Report,Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism **Case studies:** Discussion of case studies specific to the domain area of specialization	

Course Outcomes
After going through this course the student will be able to:

CO1:	Explain the principles and concepts of research types, data types and analysis procedures.
CO2:	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3:	Present research output in a structured report as per the technical and ethical standards.
CO4:	Create research design for a given engineering and management problem situation.

Reference Books

1	Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 4th edition, ISBN: 978-93-86649-22-5
2	Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3	William M. K. Trochim, James P. Donnelly, The Research Methods Knowledge Base, 3rd Edition, Atomic Dog Publishing, 2006. ISBN: 978-1592602919
4	Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
MINOR PROJECT						
Course Code	**:**	**18MBS24**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:4**		**SEE Marks**	**:**	**100**
Credits	**:**	**02**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes
After completing the course, the students will be able to:

CO1	Conceptualize, design and implement solutions for specific problems.
CO2	Communicate the solutions through presentations and technical reports.
CO3	Apply resource managements skills for projects.
CO4	Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination
Evaluation will be carried out in 3 phases. The evaluation committee will comprise of 4 members: Guide, Two Senior Faculty Members and Head of the Department.

Phase	**Activity**	**Weightage**
I	Synopsys submission, Preliminary seminar for the approval of selected topic and objectives formulation	20%
II	Mid term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

** Phase wise rubrics to be prepared by the respective departments

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/ experimental setup 25%
- Conducting experiments/ implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme of Semester End Examination (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

- Brief write up about the project 05%
- Presentation / Demonstration of the Project 20%
- Methodology and Experimental results & Discussion 25%
- Report 20%
- Viva Voce 30%

SEMESTER: II					
BIOSTATISTICS (Professional Elective-C1)					
Course Code	**:**	**18MBS2C1**		**CIE Marks**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**100**
Hours	**:**	**52L**		**SEE Duration**	**3Hrs**

Unit-I	**10 Hrs**
Introduction to Biostatistics: Introduction, Some basic concepts, Measurement and Measurement Scales, Simple random sample, Computers and bio statistical 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.	
Unit – II	**10 Hrs**
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	
Unit -III	**11 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 and difference between two population proportions, determination of sample size for estimating means, estimating proportions, confidence interval for the variance of normally distributed population and ratio of the variances of two normally distributed populations.	
Unit –IV	**11 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	
Unit –V	**10 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.	

Course Outcomes

After completing the course, the students will be able to:

CO1:	Understand basic statistical concepts commonly used in Health Sciences
CO2:	Apply the concept of Biostatistics to simplify the data aspect to solve problems.
CO3:	Analyze the biological data using the concepts of Distributions for simplification of usage.
CO4:	Evaluate a given problem and test the correctness of the analysis.

Reference Books

1	Biostatistics-A Foundation for Analysis in the Health Sciences, Wayne W. Daniel, 10th Edition, 2013,John Wiley & Sons Publication, ISBN: 978-1118302798.
2	Principles of Biostatistics, Marcello Pagano and KimberleeGauvreu, 2nd Edition, 2000, Thomson Learning Publication, ISBN: 978-0534229023.

3	Introduction to Biostatistics-A Guide to Design, Analysis and Discovery, Ronald N Forthofer and EunSul, 2nd Edition, 2006,Lee, Academic Press, ISBN: 978-0123694928.
4	Basic Biostatistics and its Applications, Animesh K. Dutta,1stEdition,2012,New Central Book Agency Pvt Ltd,ISBN 13: 978-8173815034.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MACHINE LEARNING **(Professional Elective-C2)** **Common to VLSI, CS, CNE, DCE, MBS**						
Course Code	**:**	**18MCS2C2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10 Hrs**
Introduction: Overview ofProbability Theory, Model Selection, Introduction to Machine learning. Linear Regression – Basis Function models, Bias Variance Decomposition, Bayesian linear Regression; Stochastic gradient Descent, Discriminant Functions, Bayesian Logistic regression. Examples on linear regression, logistic regression	
Unit – II	**11 Hrs**
Supervised Learning Kernel Methods: Dual representations, Construction of a kernel, Radial Basis Function Networks, Gaussian Process, Tree Based methods.Sparse Kernel Machines: Maximum margin classifiers (SVM), RVM.Examples on spam, mixer and k nearest neighbour	
Unit – III	**11 Hrs**
Unsupervised Learning **Mixture Models:** K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures, The EM Algorithm in General, Principal Component Analysis, Probabilistic PCA. Examples on Market booklet analysis	
Unit – IV	**11 Hrs**
Random Forests Introduction, Definition of Random Forests, Details of Random ,Out of Bag Samples , Variable Importance, Proximity Plots, Random Forests and Over-fitting, Analysis of Random Forests, Variance and the De-Correlation Effect, Bias, Adaptive Nearest Neighbors.	
Unit –V	**09 Hrs**
Ensemble Learning Introduction, Boosting and Regularization Paths, Penalized Regression, The "Bet on Sparsity" Principle, Regularization Paths, Over-fitting and Margins, Learning Ensembles, Learning a Good Ensemble, Rule Ensembles	

Course Outcomes

After going through this course the student will be able to:

CO1	Explore the basics of Probability, data distributions and neural networks Algorithms.
CO2	Apply the various dimensionality reduction techniques and learning models for the given Application.
CO3	Analyze the different types of supervised and unsupervised learning models.
CO4	Evaluate the classification and regression algorithms for given data set.

Reference Books

1.	Pattern Recognition and Machine Learning, Christopher M Bishop,2nd Edition, February 2006,Springer, ISBN-13: 978-0387-31073-2.
2.	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, and Jerome Friedman, 2nd Edition, 2008, Springer, ISBN 978-0-387-84858-7
3.	Data Mining – Concepts and Techniques, Jiawei Han and Micheline Kamber, Morgan Kaufmann, 3rd Edition, 2006,Elsevier, ISBN 1-55860-901-6
4.	Practical data science with R, Zumel, N., & Mount, J, 2014, Manning Publications ISBN 9781617291562

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II					
BIOMECHANICS (Professional Elective-C3)					
Course Code	**:**	**18MBS2C3**		**CIE Marks:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks:**	**100**
Hours	**:**	**52L**		**SEE Duration:**	**3Hrs**

Unit-I	**10 Hrs**

Bio-fluid mechanics:
Newton's laws, Stress and Strain, Viscosity, Relationship between diameter, velocity and pressure of blood flow, Resistance against flow.

Flow properties of blood:
Physical, Chemical and Rheological properties of blood, Blood viscosity variation, Problems associated with extra corporeal blood flow.

Unit – II	**10 Hrs**

Bioviscoelastic fluid:
Viscoelasticity, Viscoelastic Models: Maxwell, Voigt and Kelvin Models, Bio-Viscoelastic fluids.

Rheology of blood in microvessels:
Fahreus-Lindquist effect and inverse effect, hematocrit in very narrow tube.

Unit -III	**11 Hrs**

Cardiac mechanics:
Cardiovascular system, Mechanical properties of Blood vessels, Blood flow, Physics of cardiovascular diseases, Prosthetic heart valves.

Respiratory mechanics:
Alveoli mechanics, Interaction of blood and lung, P-V curve of lung, Breathing mechanism, airway resistance, Physics of lung diseases

Unit –IV	**11 Hrs**

Soft tissue mechanics:
Mechanical Properties, Structure, function and mechanical properties of skin, ligaments and tendons, Measuring principles of Cutometer, Durometer, Ballistometer.

Unit –V	**10 Hrs**

Orthopaedic mechanics:
Mechanical properties of cartilage, Mechanical properties of bone, Kinetics and Kinematics of joints, Fundamental concepts of Gait analysis, Design of force platforms, Integrating force and Kinematic data

Course Outcomes
After completing the course, the students will be able to:

CO1	Understand the basic mechanical concepts and relate the same to human physiology.
CO2	Apply core concepts of biomechanics to solve engineering problems.
CO3	Analyze the dynamics of human movement and comprehend the biomechanical principles that relate to movement and communication disabilities.
CO4	Develop and apply the principles of biomechanics to a range of rehabilitation strategies and problem solving.

Reference Books

1	Biomechanics- Mechanical properties of living tissues, Y. C. Fung, 2nd Edition, 2011, Springer Verlag,ISBN: 978-0-387-94384-8.
2	Introductory Biomechanics, C. Ross Ethier, Craig A. Simmons, 1st Edition, 2009, Cambridge University Press,ISBN-13 :978-0-521-84112-2.
3	The Biomedical Engineering Handbook, Joseph D Bronzino, 3rd Edition, 2006, CRC press,ISBN: 0-8493-046-1.
4	Fundamentals of Biomechanics, Duane Knudson, 2nd Edition,2007,Springer, ISBN 978-0-387-49311

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II					
LASERS IN MEDICINE (Professional Elective-D1)					
Course Code	**:**	**18MBS2D1**		**CIE Marks**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**100**
Hours	**:**	**52L**		**SEE Duration**	**3Hrs**

Unit-I	**10 Hrs**
Basics of Lasers: Principle of operation of laser, Characteristics of stabilization, Q-switching and mode locking, frequency stabilization, Line shape function, lasing threshold. **Major types of lasers**: construction of Ruby, He-Ne, Nd-YAG, semiconductor, Argon and Carbon dioxide lasers, safety with lasers.	
Unit – II	**10 Hrs**
Optical fibers and theirproperties: Introduction to Optical Fibers, principles of light propagation through a fiber, Different types of fibers and their properties, Transmission characteristics of optical fiber, Absorption losses, Scattering losses, Dispersion, advantages and disadvantages of optical fibers.	
Unit -III	**11 Hrs**
Light Sources and Detectors, Light sources for fiber optics, photo detectors, source coupling, splicing and connectors, Waveguides and Micro-Optical Fiber Bundles. **Optical and Thermal Response of Tissue to Laser Radiation**: Introduction, The optical response of tissue, thermal response. Light interaction with tissue, Spectroscopic diagnostics of malignant tumor, spectroscopic diagnostics of atherosclerotic plaque, light scattering and tissue trans illumination	
Unit –IV	**11 Hrs**
Therapeutic and Diagnostic Application of Laser in Ophthalmology and Case Studies: Transmission and absorptive properties of ocular tissues, photo thermal laser application, photo disruptive laser application, photochemical laser application. **Case Studies:** Laser interstitial thermal therapy (LITT), Lithotripsy, photo bleaching, photofrin photodynamic therapy in head and neck cancer, surgical application of laser in cardiology, Dentistry. **Clinical Applications of Fiberoptic Laser System:** Fiber optic Laser System in Gastroenterology, Neurosurgery, Gynecology.	
Unit –V	**10 Hrs**
Application of Laser in Dermatology: Vascular Lasers: Introduction, essential concepts, Vascular Laser Biology, Chromophores, and Tissue Targets, Laser Settings: Pulse Duration, Spot Size, Fluence, and Cooling Methods, Classification of Vascular Lesions. **Lasers in Hair Removal:** Hair Removal and Laser Biology, Further Laser Biology: Wavelength, Spot Size, Fluence, and Cooling Methods, IPL Devices and Hair Removal, RF Devices and Hair Removal. **Pearls and Problems:** Patient Selection and Pre-Treatment Care, General Treatment Pearls, Normal-Mode Ruby Laser, Normal-Mode Alexandrite Laser, Diode Lasers, Long-Pulsed Nd:YAG Laser	

Course Outcomes **After completing the course, the students will be able to:**	
CO1	Understand the basic concepts of lasers and optical fibers.
CO2	Apply the knowledge of fiber optic laser system to various healthcare applications
CO3	Analyze the effect of using Lasers for diagnosis, therapeutic and treatment of various health issues.
CO4	Evaluate the choice of laser for the application intended.

Reference Books	
1	Masers and Lasers, Mario Bertolotti, second edition, 2016,CRC press, ISBN:9781482261066.
2	Laser principles and applications, Wilson and Hawkes, 7th Edition, 1987,Prentice Hall of India, ISBN: 978-0135237052.
3	Lasers in Medicine, Ronald W. Waynant (Editor),1stEdition,Jan 2002, CRC press,ISBN 978-0849311468.
4	Laser Dermatology -Pearls and Problems, David J. Goldberg,2ndEdition, 2008, Blackwell PublishingISBN-13: 978-1-4051-3420-0.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II					
IoT FOR HEALTHCARE (Professional Elective-D2)					
Course Code	**:**	**18MBS2D2**		**CIE Marks**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**100**
Hours	**:**	**52L**		**SEE Duration**	**3Hrs**

Unit-I	**10 Hrs**
IoT Landscape: Introduction to IoT ,Applications , Architectures , Wireless Networks ,Security and Privacy , Event-Driven Systems IoT System Architectures Basic building blocks of IoT architecture, Introduction Protocols Concepts , IoT-Oriented Protocols Databases Time Bases Security IoT Smart X Applications- Smart health platform, Smart energy, Smart home, Smart food, water, tracking and sensitivity	
Unit – II	**10 Hrs**
IoT and Assistive Technologies for people with disabilities: IoT - integrated state-of-the-art assistive technology, IoT applications for people who are deaf/hearing impaired, blind/visually impaired, and mobility disability. Smart Sensors, Self Powered sensors, Nano-technology sensors, Issues of the IoT-based assistive technology for people with disabilities.	
Unit -III	**11 Hrs**
IoT for ambient assisted living:Introduction, system design, general architecture, wearable devices, experimental evaluation, functional list, operation list, and results. **Hybrid integration system for wearable sensor system-** Introduction, State-of-the-art of current health care wearable system(WHCS), a desirable WHCS, customized IC for wearable sensors, State-of-the-Art SoC technology, Bio sensing SoC architecture and applications	
Unit –IV	**11 Hrs**
Hybrid integration system for wearable sensor system: Printed electrodes and their characteristics, electrode technology, active electrode, passive electrode, dry electrode. **Hybrid integration of flexible wearable sensors:** flexible circuits and interconnection, silicon on flex bio-patch implementation and miniaturization.	
Unit –V	**10 Hrs**
Role of time in IoT: Introduction, Blood flow analysis, circulation diagnosis, flow quantification, synchronization in space, blood pressure, health things-single device, distinct times, multiple device-single time, redundant device, tolerance, data reliability. **Case studies:** Fall detection, Physical monitoring of aged people, hygienic hand control, Chronic disease management, sports men care, remote control appliances, sleep control, animal/ human tracking, indoor climate control, waste management, etc (any one per student).	

Course Outcomes

After completing the course, the students will be able to:

CO1	Understand the fundamentals required for IoT.
CO2	Apply the concepts of IoT to medical devices.
CO3	Evaluate performance of IoT against other technologies.
CO4	Create an IoT application for biomedical Engineering

Reference Books

1	Internet of Things from research and Innovations to market development, OvidiuVermsan, Peter Friess, 1st Edition, 2014, River publishers, ISBN: 978-87-93102-94-1.
2	IoT and advanced applications in health care, Catarina Reiss, Marisa da silvamaximiano, 1st Edition,2017, IGI Global publication, ISBN: 9781522518211(ebook).
3	Internet-of-Things (IoT) Systems Architectures, Algorithms, Methodologies, DimitriosSerpanos, Marilyn Wolf,2018, Springer International Publishing AG, ISBN 978-3-319-69714-7.
4	The Industry 4.0- The Industrial Internet of Thing, Alasdair Gilchrit, Edition, 2016, Apress, Publication ISBN 978-1-4842-2046-7

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: III					
BASICS OF ORTHOPAEDICS, MEDICINE& ETHICS (Professional Elective-D3)					
Course Code	**:**	**18MBS2D3**		**CIE Marks**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**100**
Hours	**:**	**52L**		**SEE Duration**	**3Hrs**

Unit-I	**10 Hrs**
Introduction to Orthopedics: Basics of orthopedics, Skeletal System Organization, Bone formation and growth, Fracture healing. **General Orthopedics:** a) Gait b) Amputations. c) Bone densitometry d) Arthroscopy.	
Unit – II	**10 Hrs**
Medical Ethics: Theory, principles, rules and moral decisions, Belmont report, the principles of biomedical ethics: respect for autonomy, voluntariness information and informed consent, competency, non-malfeasance, the rule of the double effect, befecience, paternalism, justice, agencies validating the medical equipments	
Unit -III	**11 Hrs**
Introduction to Medicine: General Physical Examination of the patient, Case sheet writing. **Diseases associated with Respiratory system and Cardiovascular system**; Basic Investigations of Respiratory and CVS, Cough and Sputum, Bronchial-Asthma, COPD, Pulmonary Tuberculosis, Cardiac arrest, Ischaemic Heart Disease	
Unit –IV	**11 Hrs**
Neurology and Renal Disorders; Basic Investigations in Neurology and Renal diseases**,** Epilepsy, Cerebrovascular Diseases, Myasthenia gravis, Acute and chronic renal failure, Glomerular Diseases, UTI, Renal Calculi	
Unit –V	**10 Hrs**
EYE: Blindness, causes of blindness ,cataract, glaucoma, **E.N.T:** Causes of Deafness, Tests for diagnosis of Deafness. **Communicable and Non-Communicable Diseases:** Malaria, Typhoid, Vector borne viral fever-Dengue, Chikungunya& Yellow fever. Hypertension and Diabetes Types of Diabetes and Management of Diabetes	

Course Outcomes

After completing the course, the students will be able to:

CO1	Understand common diseases, their diagnosis and treatment procedures.
CO2	Apply necessary equipment used for investigations in diagnosing of diseases.
CO3	Analyze the factors that are affecting the cause for disease using necessary medical equipment
CO4	Develop the habit of applying medical ethics in detecting, diagnosing and use of medical equipment

Reference Books

1	Hand book of osteology, S.Poddar, Ajay Bhagat, Scientific Book Company,14th Edition, 2017, Scientific book company Publication, ISBN: 978-93-84448-44-8
2	Essential orthopedics (includes clinical methods),J.Maheshwari, Vikram A. Mhaskar, 5th Edition, 2015,Jaypee Brothers Medical Pub , ISBN-13: 978-9351968085
3	Clinical Medicine for students, Golwalla, 25th Edition, 2017, National Publication, ISBN: 9789351524748
4	Basic principles and acquisition of Intellectual Property Rights, Dr. T Ramakrishna, CIPRA, NSLIU -2005.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
BUSINESS ANALYTICS (Global Elective-G01)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.	
Unit – II	**08 Hrs**
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	
Unit – III	**08 Hrs**
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.	
Unit – IV	**08 Hrs**
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.	
Unit –V	**07 Hrs**
Decision Analysis: Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	

Course Outcomes
After going through this course the student will be able to:

CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

Reference Books

1	Business analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402
2	The Value of Business Analytics: Identifying the Path to Profitability, Evan Stubs , John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881,1st Edition 2014
3	Business Analytics,James Evans, Pearsons Education 2nd Edition, ISBN-13:978-0321997821ISBN-10:0321997824
4	Predictive Business Analytics Forward Looking Capabilities to Improve Business,GaryCokins and Lawrence Maisel, Wiley; 1st Edition, 2013.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II					
INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY (Global Elective-G02)					
Course Code	**:**	**18CV2G02**		**CIE Marks**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**100**
Hours	**:**	**39L**		**SEE Duration**	**3Hrs**
Unit – I					**7Hrs**
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.					
Unit – II					**9Hrs**
Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.					
Unit – III					**9Hrs**
HazardousMaterials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.					
Unit – IV					**7Hrs**
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii.Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.					
Unit – V					**7Hrs**
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.					
Course Outcomes **After successful completion of this course the student will be able to:**					
CO1	Explain the Industrial and Occupational health and safety and its importance.				
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.				
CO3	Characterize the different type materials, with respect to safety and health hazards of it.				
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.				

Reference Books	
1.	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services
2.	H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009,S. Chand and Company, New Delhi, ISBN:9788121926447
3.	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition,2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1
4.	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
MODELING USING LINEAR PROGRAMMING (Global Elective-G03)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	
Unit – II	**08 Hrs**
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	
Unit – III	**08 Hrs**
Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality	
Unit – IV	**08 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.	
Unit –V	**07 Hrs**
Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the various Linear Programming models and their areas of application.
CO2	Formulate and solve problems using Linear Programming methods.
CO3	Develop models for real life problems using Linear Programming techniques.
CO4	Analyze solutions obtained through Linear Programming techniques.

Reference Books

1	Taha H A, Operation Research An Introduction, PHI, 8th Edition, 2009, ISBN: 0130488089.
2	Philips, Ravindran and Solberg - Principles of Operations Research – Theory and Practice, John Wiley & Sons (Asia) Pvt Ltd, 2nd Edition, 2000, ISBN 13: 978-81-265-1256-0
3	Hiller, Liberman, Nag, Basu, Introduction to Operation Research, Tata McGraw Hill 9th Edition, 2012, ISBN 13: 978-0-07-133346-7
4	J K Sharma, Operations Research Theory and Application, Pearson Education Pvt Ltd, 4th Edition, 2009, ISBN 13: 978-0-23-063885-3.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
PROJECT MANAGEMENT (Global Elective-G04)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.	
Unit – II	**08 Hrs**
Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting	
Unit – III	**08 Hrs**
Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis	
Unit – IV	**08Hrs**
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management	
Unit-V	**07 Hrs**
Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile. **Domain Specific Case Studies on Project Management:** Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.	

Course Outcomes

After going through this course the student will be able to:

CO1	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	Evaluate the budget and cost analysis of project feasibility.
CO3	Analyze the concepts, tools and techniques for managing projects.
CO4	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books

1	Prasanna Chandra, Project Planning Analysis Selection Financing Implementation & Review, Tata McGraw Hill Publication, 8th Edition, 2010, ISBN 0-07-007793-2.
2	Project Management Institute, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Harold Kerzner, Project Management A System approach to Planning Scheduling & Controlling, John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
4	Rory Burke, Project Management – Planning and Controlling Techniques, John Wiley & Sons, 4th Edition, 2004, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II					
ENERGY MANAGEMENT (Global Elective-G05)					
Course Code	**:**	**18CH2G05**		**CIE Marks:**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**3Hrs**

Unit-I	**08 Hrs**
Energy conservation: Principles of energy conservation, Energy audit and types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat Exchangers and classification.	
Unit-II	**08 Hrs**
Wet Biomass Gasifiers: Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages.	
Unit -III	**08 Hrs**
Dry Biomass Gasifiers : Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.	
Unit -IV	**08 Hrs**
Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication. **Wind Energy:** Classification, Factors influencing wind, WECS & classification.	
Unit -V	**07 Hrs**
Alternative liquid fuels: Introduction, Ethanol production: Raw materials, Pre-treatment, Conversion processes with detailed flow sheet.Gasification of wood: Detailed process, Gas purification and shift conversion, Biofuel from water hyacinth.	

Course Outcomes
After going through this course the student will be able to:

CO1:	Understand the use alternate fuels for energy conversion
CO2:	Develop a scheme for energy audit
CO3:	Evaluate the factors affecting biomass energy conversion
CO4:	Design a biogas plant for wet and dry feed

Reference Books

1	Nonconventional energy, Ashok V Desai, 5th Edition, 2011, New Age International (P) Limited, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol.I & II, 1986, McGraw-Hill Education, ISBN-13: 978-0074517239.
3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, 2009, Prentice Hall of India, ISBN:9788120343863.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
INDUSTRY 4.0 (Global Elective-G06)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
Unit – II	**08 Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	
Unit – III	**08 Hrs**
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	
Unit – IV	**08 Hrs**
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing. Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software	
Unit –V	**08 Hrs**
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	

Course Outcomes

After going through this course the student will be able to:

CO1	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books	
1	Alasdair Gilchrist, INDUSTRY 4.0 THE INDUSTRIAL INTERNET OF THINGS,Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Alp Ustundag, EmreCevikcan, Industry 4.0: Managing The Digital Transformation, Springer, 2018 ISBN 978-3-319-57869-9.
3	OvidiuVermesan and Peer Friess, Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Rivers Publishers, 2016 ISBN 978-87-93379-81-7
4	Christoph Jan Bartodziej, The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
ADVANCED MATERIALS (Global Elective-G07)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	**07 Hrs**
Unit – II	
Non Metallic Materials: Classification of n on metallic materials, Rubber : Properties, processing and applications.Plastics : Thermosetting and Thermoplastics, Applications and properties. Ceramics : Properties and applications. Adhesives: Properties and applications. Optical fibers : Properties and applications. Composites : Properties and applications.	**08 Hrs**
Unit – III	
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	**08 Hrs**
Unit – IV	
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	**08 Hrs**
Unit –V	
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	**08 Hrs**

Course Outcomes
After going through this course the student will be able to:

CO1:	Describe metallic and non metallic materials
CO2:	Explain preparation of high strength Materials
CO3:	Integrate knowledge of different types of advanced engineering Materials
CO4:	Analyse problem and find appropriate solution for use of materials.

Reference Books

1	Donald R. Askeland, and Pradeep P. Fulay, The Science & Engineering of Materials, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Gregory L. Timp, Nanotechnologym 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Dr. VD Kodgire and Dr. S V Kodgire, Material Science and Metallurgym 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	N Bhatnagar, T S Srivatsan, Processing and Fabrication of Advanced Materials, 2008, IK International, ISBN: 978819077702

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II					
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Global Elective-08)					
Course Code:	**:**	**18CHY2G08**		**CIE Marks**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks**	**100**
Hours	**:**	**39L**		**SEE Duration**	**3Hrs**

Unit-I — **08 Hrs**

Introduction to composite materials

Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.

Unit – II — **08 Hrs**

Polymer matrix composites (PMC)

Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers,

Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**

Unit -III — **08 Hrs**

Ceramic matrix composites and special composites

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics – need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.

Unit –IV — **08 Hrs**

Metal matrix composites

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures.Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries.

Unit –V — **07 Hrs**

Polymer nano composites

Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles.Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques.Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM.Mechanical and Rheological properties of Polymer Nano composites. Gas barrier, Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites. Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nano-composites.

Course Outcomes **After completing the course, the students will be able to:**	
CO1	Understand the purpose and the ways to develop new materials upon proper combination of known materials.
CO2	Identify the basic constituents of a composite materials and list the choice of materials available
CO3	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
CO4	Get insight to the possibility of replacing the existing macro materials with nano-materials.
Reference Books	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd Edition Springer-verlagGmbh, , ISBN: 9780387743646, 0387743642
2	The Science and Engineering of Materials, K Balani, Donald R Askeland, 6th Edition-Cengage, Publishers, ISBN: 9788131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, ISBN: 9780137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis, ISBN: 9781498761666, 1498761666

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II					
PHYSICS OF MATERIALS (Global Elective-09)					
Course Code	**:**	**18PHY2G09**		**CIE Marks**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks**	**100**
Hours	**:**	**39L**		**SEE Duration**	**3Hrs**

Unit-I	**07 Hrs**
Crystal Structure : Symmetry elements-seven crystals systems-Reciprocal lattice-Packing fraction, Lattice Vibration-Brillouin zones, Analysis of Crystal structure using XRD, Thermal properties.	
Unit-II	**07 Hrs**
Dielectric Materials: Basic concepts-Langevin's Theory of Polarisation-Clausius-Mossotti Relation-Ferro electricity-Piezoelectricity-Properties of Dielectric in alternating fields-The complex Dielectric Constant and Dielectric Loss, Polarizability as a function of frequency-Complex dielectric constant of non-polar solids-Dipolar relaxation, Applications.	
Unit -III	**07Hrs**
Magnetic Materials : Dia and Paramagnetic materials-Quantum theory of paramagnetic materials-Paramagnetic susceptibility of conduction electrons-Ferro-anti ferromagnetic materials-Superconductors and Applications.	
Unit -IV	**07 Hrs**
Semiconducting Materials Semiconductor-Direct and Indirect bonding characteristics-Importance of Quantum confinement-quantum wires and dots-Ferro electric semiconductors-applications-Polymer semiconductors-Photo conductive polymers, Applications.	
Unit -V	**08 Hrs**
Novel Materials Smart materials-shape memory alloys-shape memory effects-Martensitia Transformation functional properties-processing-texture and its nature.	

Course Outcomes

After completing the course, the students will be able to:

CO1:	Analyse crystals using XRD technique.
CO2:	Explain Dielectric and magnetic materials.
CO3:	Integrate knowledge of various types of advanced engineering Materials.
CO4:	Use materials for novel applications.

Reference Books

1	Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN 10-8122436978.
2	Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971-51-180.
3	Material Science, Rajendran V and Marikani, 1stEdition, Tata McGraw Hill, ISBN 10-0071328971.
4	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II					
ADVANCED STATISTICAL METHODS (Global Elective-G10)					
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks**	**100**
Hours	**:**	**39**		**SEE Duration**	**3 Hrs**

Unit-I	**07 Hrs**

Sampling Techniques:
Random numbers, Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement). Expectation and standard error of sample mean and proportion.

Unit-II	**08 Hrs**

Estimation:
Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Properties of maximum likelihood estimator (no proofs), Confidence intervals-population mean (large sample), population proportion.

Unit -III	**08Hrs**

Tests of Hypothesis:
Principles of Statistical Inference, Formulation of the problems with examples, Simple and composite hypothesis, Null and alternative hypothesis, Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Chi squared test for goodness of fit.

Unit -IV	**07 Hrs**

Linear Statistical Models:
Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell.

Unit -V	**09 Hrs**

Linear Regression:
Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.

Course Outcomes
After completing the course, the students will be able to:

CO1:	Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.
CO2:	Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors,one way ANOVA, linear and multiple linear regressions.
CO3:	Analyse the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.
CO4:	Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations.

Reference Books

1	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.
2	Applied Statistics and Probability for Engineers, John Wiley & Sons, Inc., 3rd Edition, 2003, ISBN 0-471-20454-4.
3	S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistic, D. C. Montgomery and G. C. Runger, 10th Edition, 2000, A Modern Approach, S Chand Publications, ISBN 81-7014-791-3.
4	Regression Analysis: Concepts and Applications , F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press, ISBN-13: 978-0534198695.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SYLLABUS
FOR
SEMESTER III & IV

SEMESTER : III						
MEDICAL IMAGING TECHNIQUES (Theory)						
Course Code	**:**	**18MBS31**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:1:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L+26T**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 Hrs**

Introduction: Basic imaging principle, Imaging modalities-Projection radiography, Computed Tomography, Nuclear medicine, Ultrasound imaging, Magnetic Resonance Imaging.

X-Ray : 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.

Unit – II **10 Hrs**

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.

Unit – III **12 Hrs**

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

Infra Red Imaging : Physics of thermography – imaging systems – pyroelectricvidicon camera clinical thermography – liquid crystal thermography

Unit – IV **10 Hrs**

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

Unit – V **10 Hrs**

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.

Course Outcomes

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

CO1	Understand the basic principles of various imaging methodologies.
CO2	Apply an appropriate imaging technique for a specific medical application.
CO3	Select a suitable imaging technique taking into account its characteristics.
CO4	Analysis and evaluate the performance of different imaging techniques with respect to medical diagnostics.

Reference Books

1.	Principles of Medical Imaging, K Kirk Shung, Michael B Smith &Benjamim M W Tsui, 1st Edition 2012, Academic Press ,ISBN: 978-0126409703.
2.	Medical Imaging Signals and Systems, Jerry L Prince & Jonathan M Links, 2006 Edition, Pearson Prentice Hall, ISBN: 9780130653536.
3.	The physics of medical imaging, Steve Webb, 1988, IOP Publishing Ltd, ISBN 0-85274-361-0.
4.	Basics of MRI, Ray H Hashemi& William G Bradley Jr, 2nd Edition, 2004, Lippincott Williams & Wilkins Publications, ISBN: 978-0781741576.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE(Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: III						
INTERNSHIP						
Course Code	**:**	**18MBS32**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1) The duration of the internship shall be for a period of 8 weeks on full time basis after II semester final exams and before the commencement of III semester.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4) Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5) Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.
7) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization : Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 - Activities of the Department
    - Chapter 3 - Tasks Performed : summaries the tasks performed during 8 week period
    - Chapter 4 – Reflections : Highlight specific technical and soft skills that you acquired during internship
    - References & Annexure

Course Outcomes

After going through the internship the student will be able to:

CO1: Apply engineering and management principles
CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.

The evaluation criteria shall be as per the rubrics given below:

Reviews	**Activity**	**Weightage**
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments,	45%
Review-II	Importance of resource management, environment and sustainability presentation skills and report writing	55%

Scheme for Semester End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner (domain expert) and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER: III						
MAJOR PROJECT : PHASE-I						
Course Code	**:**	**18 MBS33**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. The Major Project work comprises of Phase-I and Phase-II. Phase-I is to be carried out in third semester and Phase-II in fourth semester.
2. The total duration of the Major project Phase-I shall be for 16 weeks.
3. Major project shall be carried out on individual student basis in his/her respective PG programme specialization. Interdisciplinary projects are also considered.
4. The allocation of the guides shall be preferably in accordance with the expertise of the faculty.
5. The project may be carried out on-campus/industry/organization with prior approval from Internal Guide, Associate Dean and Head of the Department.
6. Students have to complete Major Project Phase-I before starting Major Project Phase-II.
7. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in tworeviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	**Activity**	**Weightage**
Review-I	Selection of the topic, Literature Survey, Problem Formulationand Objectives	45%
Review-II	Methodology and Report writing	55%

Scheme for Semester End Evaluation (SEE):

Major Project Phase-I evaluation shall be done by an external examiner (domain expert) and respective guide as per the schedule. Maximum of four candidates per batch shall be allowed to take examination. The batches are to be formed based on specific domain of work.

SEMESTER : III						
ARTIFICIAL ORGANS AND BIOMATERIALS (ProfessionalElective-E1)						
Course Code	**:**	**18MBS3E1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10 Hrs**

Structure of Biomaterials and Biocompatibility

Definition and classification of biomaterials, mechanical properties, viscoelasticity, wound-healing process, body response to implants, blood compatibility

Unit – II **10 Hrs**

Implant materials

Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, medical applications.

Polymeric implant materials

Polymerization, Basic Structure, Effect of Structural Modification on Properties, polyamides, Acrylic polymers, rubbers, high strength thermoplastics, medical applications. Biopolymers:Collagen and Elastin.

Unit – III **12 Hrs**

Tissue replacement implants

Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements,visual and audio testing.

Unit – IV **10 Hrs**

Artificial Organs

Artificial Heart : Structure and function, Prosthetic Cardiac Valves, Artificial lung (oxygenator).

Artificial Kidney : Structure and function, Kidney disease, Renal failure, Mass transfer in dialysis, Clearance, Filtration, Permeability, Membranes, Hemofiltration.

Unit – V **10 Hrs**

Artificial Organs

Liver Support Systems: Morphology & functions, Hepatic failure, Liver support systems, Hybrid Replacement procedures, Global Replacement of liver function, Bio-artificial systems.

Artificial Pancreas: Structure and function, diabetes, insulin, insulin therapy, insulin administration & production systems.

Course Outcomes

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

CO1	Understand the principles of material science engineering.
CO2	Apply core concepts of material science to solve engineering problems.
CO3	Analyze the structure and working of artificial organs.
CO4	Design a prototype model using the biomaterial.

Reference Books

1.	The Biomedical Engineering Handbook, Joseph D Bronzino, Third Edition, 2006, CRC press, USA, ISBN: 0-8493-046-1
2.	Biomaterials Science and Engineering, Park J.B, 2009, Plenum Press, ISBN: 978-1-4613-2769-1.
3.	Biomaterials Science: An Introduction to Materials in Medicine,Buddy D. Ratner , Allan S. Hoffman, Frederick J. Schoen Jack E. Lemons, Academic Press Inc; 3rd Edition,2012, 978-0123746269
4.	Introduction to Biomedical Engineering, John Enderle, Joseph D. Bronzino, Susan M. Blanchard, 2009, Elsevier, ISBN: 978-0-1223-8662-6.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE(Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: III						
REHABILITATION ENGINEERING (ProfessionalElective-E2)						
Course Code	**:**	**18MBS3E2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**10 Hrs**
Rehabilitation Fundamentals: Rehabilitation concepts, Engineering concepts in sensory rehabilitation, Engineering concepts in motor rehabilitation Future of engineering in Rehabilitation						
Unit – II						**10 Hrs**
Prosthetic And Orthotic Devices: Hand and arm replacement, different types of models for externally powered limb prosthetics, Lower limb, Upper limb orthotics, and material for prosthetic and orthotic devices, mobility aids.						
Unit – III						**12 Hrs**
Auditory And Speech Assist Devices: Types of deafness, hearing aids, application of DSP in hearing aids, Cochlear implants, Voice synthesizer, speech trainer.						
Unit – IV						**10 Hrs**
Visual Aids: Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers.						
Unit – V						**10 Hrs**
Medical Stimulator: Muscle and nerve stimulator, Location for Stimulation, Functional Electrical Stimulation, Sensory Assist Devices, Design issues.						

Course Outcomes

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

CO1: Understanding of the various rehabilitation aid principles and its working.

CO2: Apply the appropriate rehabilitation concept for various disabilities.

CO3: Analyze and compare the different methods of selected rehabilitation aid for various disabilities.

CO4: Design and develop orthotic and prosthetic rehabilitation aid.

Reference Books

1.	An Introduction to Rehabilitation Engineering, Rory A Cooper,2012, Taylor and Francis, London, ISBN-13 : 9781420012491
2.	The Biomedical Engineering Handbook, Joseph D.Bronzino, 4thEdition ,Taylor& Francis, 2015, ISBN :1439825335, 9781439825334.
3.	Advances in Bio Medical Engineering and Medical Physics, Levine.S.N.Editor, Inter University Publication, New York 1968.
4.	Therapeutic Medical devices, Albert M.Cook and Webster J.G, Prentice Hall Inc., NewJersy, 1982.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE(Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : III						
ERGONOMICS (ProfessionalElective-E3)						
Course Code	**:**	**18MBS3E3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — **10 Hrs**

Introduction: Principles, Scope and Application of Ergonomics.

Applied Anthropometry

Static Dimensions, Dynamic (Functional) Dimensions, Use of Anthropometric Data.

Unit – II — **10 Hrs**

Work-Space Design, and Seating

Work-Space Envelopes for Seated Personnel, Work-Space Envelopes for Standing Personnel

Design of work surfaces

Horizontal Work Surface Area, Work-Surface Height: Seated**,** Work-Surface Height: Standing, General Principles of Seat Design**,** Specific Design Recommendations, Seat Designs for Specific Purposes, video display terminal (vdt) workstations.

Unit – III — **12 Hrs**

Design of repetitive tasks

Introduction to work-related musculoskeletal disorders ,Injuries to the upper body at work ,Review of tissue path mechanics and WMSDs, Disorders of the neck ,Carpal tunnel syndrome Tennis elbow (epicondylitis), Disorders of the shoulder Lower limbs, Ergonomic interventions, Trends in work-related musculoskeletal disorders.

Unit – IV — **10 Hrs**

Vision, light and lighting

Vision and the eye, Measurement of light, Lighting design considerations, Visual fatigue, eyestrain and near work, Psychological aspects of indoor lighting.

Heat, cold and the design of the physical environment

Fundamentals of human thermoregulation, Measuring the thermal environment ,Thermoregulatory mechanisms, Work in hot climates, Work in cold climates ,Skin temperature ,Protection against extreme climates, Comfort and the indoor climate ISO standards.

Unit – V — **10 Hrs**

Hearing, sound, noise and vibration

Ear protection, Design of the acoustic environment, Industrial noise control, Noise and communication The auditory environment outdoors, Effects of noise on task performance ,Non-auditory effects of noise on health, Noise and satisfaction, Vibration.

Course Outcomes

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

CO1	Understand the techniques, skills, and modern human factors and workplace ergonomics tools necessary for industrial and systems engineering practice.
CO2	Apply basic knowledge of physical factors affecting human beings in relation to light, lighting, sound and noise, climate and vibrations.
CO3	Analyse and reflect on the results of ergonomic analysis of product systems and draw conclusions and give recommendations.
CO4	Design a system, component, or process to meet accepted human factors and workplace ergonomics standards

Reference Books	
1.	Introduction to Ergonomics, Bridger, R.S. 3rd edition, 2008, McGraw Hill, ISBN-13: 978-0849373060.
2.	Human Factors in Engineering and Design, Sanders and McCormick, McGraw-Hill Book Co., Inc., New York, 7th Edition, 2013. ISBN 13: 9780070549012.
3.	Fitting the task to Man, Grandjaen, 2008, Taylor Pub, ISBN-13: 978-0850663792.
4.	A Guide to Human factors and Ergonomics, Martin Helander, 2006, TMH, ISBN-13: 978-0415282482.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE(Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: IV						
MAJOR PROJECT : PHASE II						
Course Code	**:**	**18MBS41**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:20**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**40**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Major Project Phase-II is continuation of Phase-I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of methodology, algorithm development, experimentation, testing and analysis of results.
4. It is mandatory for the student to present/publish the work in National/International conferences or Journals
5. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the students will be able to

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in threereviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Review and refinement of Objectives, Methodology and Implementation	20%
Review-II	Implementation, Testing, Verification and Validation of results, Conclusions and Future Scope of Work	40%
Review-III	Report Writing and Paper Publication	40%

Scheme for Semester End Evaluation (SEE):

Major Project Phase-II SEE shall be conducted in two stages. This is initiated after fulfilment of submission of project report and CIE marks.

Stage-1Report Evaluation

Evaluation of Project Report shall be done by guide and an external examiner.

Stage-2Project Viva-voce

Major Project Viva-voce examination is conducted after receipt of evaluation reports from guide and external examiner.

Both Stage-1 and Stage-2 evaluations shall be completed as per the evaluation formats.

SEE procedure is as follows:

	Internal Guide	**External Examiner**	**TOTAL**	
SEE Report Evaluation	100 marks	100 marks	200 marks	
			(A)	(200/2) = 100 marks
Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator		(B)	100 marks
Total Marks				**[(A)+(B)]/2 = 100**

SEMESTER: IV						
TECHNICAL SEMINAR						
Course Code	**:**	**18MBS42**		**CIE Marks**	**:**	**50**
Credits L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**30 Mins**

GUIDELINES

1) The presentation shall be done by individual students.
2) The seminar topic shall be in the thrust areas of respective PG programs
3) The seminar topic could be complementary to the major project work
4) The student shall bring out the technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation along with the report.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the student will be able to:

CO1: Identify topics that are relevant to the present context of the world
CO2: Perform survey and review relevant information to the field of study.
CO3: Enhance presentation skills and report writing skills.
CO4: Develop alternative solutions which are sustainable.

Scheme of Continuous Internal Evaluation (CIE): Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of Topic, Review of literature, Technical Relevance, Sustainability and Societal Concerns, Presentation Skills	45%
Review-II	Technological Developments, Key Competitors, Report writing	55%

Scheme for Semester End Evaluation (SEE):

The SEE examination shall be conducted by an external examiner and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.