Rashtreeya Sikshana Samithi Trust

R. V. College of Engineering

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Electronics & Instrumentation Engineering

Master of Technology (M. Tech.)

Biomedical Signal Processing & Instrumentation

Scheme and Syllabus for Autonomous System w.e.f 2016

R.V. College of Engineering, Bengaluru – 59

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

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.

Program Educational Objectives (PEO)

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

PEO1: Apply basic physiological concepts and provide technical solutions for medical problems.

PEO2: Exhibit competency for achieving career excellence in Industry, Academia, R & D organizations, entrepreneurial pursuit and consulting firms.

PEO3: Demonstrate and develop sustainable biomedical engineering skills for betterment of society and ethics.

PEO4: Exhibit leadership qualities and engage in life-long learning through independent study and research.

Program Outcomes (PO)

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

PO 1. Scholarship of Knowledge: Gain advanced concepts of medical and engineering fundamentals to become scholar to pursue higher studies.

PO 2. Critical Thinking: Identify, critically analyze, formulate and solve engineering problems with comprehensive knowledge in the medical domain.

PO 3. Problem Solving: Provide engineering solutions to medical problems.

PO 4. Research Skill: Contribute by research and innovation to solve biomedical engineering problems.

PO 5. Usage of modern tools: Create, select, and apply appropriate techniques, resources, and modern engineering tools such as LabVIEW, MATLAB, COMSOL, MINITAB etc for modelling complex biomedical engineering activities, with an understanding of the limitations.

PO 6. Collaborative and Multidisciplinary work: Ability to work in multidisciplinary areas related to healthcare sector.

PO 7. Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 8. Communication: Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 9. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PO 10. Ethical Practices and Social Responsibility: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 11. Independent and Reflective Learning: Developing students' capacity for independent and reflective learning in biomedical domain.

Program: Biomedical Signal Processing & Instrumentation

Program Specific Criteria (PSC):

Graduates of Biomedical Signal Processing & Instrumentation program must demonstrate:

1. The applications of biomedical sciences to develop, test, operate, and maintain biomedical equipment.
2. The ability to analyze, design, and implement biomedical engineering systems.
3. The ability to utilize statistics, transform methods, discrete mathematics and applied differential equations in support of biomedical signal and image processing.
4. An understanding of the clinical applications of biomedical equipments.

Lead Society: Biomedical Engineering Society

1. Curriculum

Biomedical Signal Processing & Instrumentation program will prepare graduates with the technical skills necessary to enter careers in the design, application, installation, operation and/or maintenance of biomedical equipment. Graduates of the program will have strengths in the building, testing, operation, and maintenance of existing biomedical equipment or systems, and are well prepared for development and implementation of biomedical equipment or systems.

2. Faculty

The major professional competence of the faculty must be in engineering, and the faculty should be experienced in the management of engineering and/or technical activities.

Program Specific Outcomes (PSO)

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

PSO1: Design and analyze basic and advanced biomedical appliances required for medical domain and research pursuits.

PSO2: Apply the concepts of signal & image processing techniques to address the problems of healthcare.

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M. Tech. in Biomedical Signal Processing &Instrumentation

FIRST SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self Study S**	
1	16MEM11R	Research Methodology	IM	3	1	0	0	4
2	16MBS12	Physiology for Biomedical Engineering	EI	4	0	0	0	4
3	16MBS13	Medical Instrumentation (Theory & Practice)	EI	4	0	1	0	5
4	16MBS14	Biomedical Signal Processing	EI	4	0	0	1	5
5	16MBS15X	Elective -1	EI	4	0	0	0	4
6	16HSS16	Professional Skill Development	HSS	0	0	2	0	2
		Total		**19**	**1**	**3**	**1**	**24**

Elective -1			
16MBS151	Biostatistics	16MBS152	Fundamentals of Real Time Signal Processing

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Department of Electronics & Instrumentation Engineering

M. Tech. in Biomedical Signal Processing &Instrumentation

SECOND SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self Study S**	
1	16MEM21P	Project Management	IM	3	1	0	0	4
2	16MBS22	Biomedical Image Processing (Theory & Practice)	EI	4	0	1	0	5
3	16MBS23X	Elective - 2	EI	4	0	0	0	4
4	16MBS24X	Elective - 3	EI	4	0	0	0	4
5	16MBS25X	Elective - 4	EI	4	0	0	0	4
6	16MBS26	Minor Project	EI	0	0	5	0	5
		Total		**19**	**1**	**6**	**0**	**26**

Elective -2			
16MBS231	Medical Imaging Techniques	16MBS232	Object Oriented Programming with C++
Elective – 3			
16MBS241	Neural networks & fuzzy logic	16MBS242	Processors for embedded system
Elective – 4			
16MBS251	Bioinformatics and Applications	16MBS252	Clinical Medicine And Ethics

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Department of Electronics & Instrumentation Engineering

M. Tech. in Biomedical Signal Processing &Instrumentation

THIRD SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self Study S**	
1	16MBS31	Bio-MEMS & NEMS (Theory & Practice)	EI	4	0	1	0	5
2	16MBS32X	Elective - 5	EI	4	0	0	0	4
3	16MBS33X	Elective - 6	EI	4	0	0	0	4
4	16MBS34X	Elective - 7	EI	4	0	0	0	4
5	16MBS35	Internship/ Industrial Training	EI	0	0	3	0	3
6	16MBS36	Technical Seminar	EI	0	0	2	0	2
		Total		**16**	**0**	**6**	**0**	**22**

Elective – 5			
16MBS321	Speech Signal Processing	16MBS322	IoT for medical applications
Elective – 6			
16MBS331	Virtual Bio Instrumentation	16MBS332	Lasers in medicine
Elective – 7			
16MBS341	Biomechanics	16MBS342	Bio Materials & Artificial Organs

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FOURTH SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self Study S**	
1	16MBS41	Major Project	EI	0	0	26	0	26
2	16MBS42	Seminar	EI	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

THIRD SEMESTER

BIO-MEMS AND NEMS						
Course Code	**:**	**16MBS31**		**CIE Marks**	**:**	**100+50**
Hrs/Week	**:**	**L: T: P: S**	**4:0:2:0**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**05**		**SEE Duration**	**:**	**3 + 3 Hrs**

Course Learning Objectives:

Students are able to

1. To know the fundamentals of MEMS and applications.
2. Understand the principles of microsystem design and miniaturization.
3. To study the applications of MEMS in the field of biomedical engineering and drug delivery.
4. To impart the knowledge about nanotechnology and development of Lab-onchip.

UNIT – I **09 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 **09 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 **09 Hrs**

Microsystems Fabrication Processes:

Introduction to Microsystem 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 **10 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	**11 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.

Unit – VI (Lab Component)	**12 Hrs**

LAB EXPERIMENTS:

Simulation Experiments: Simulation of different types of Sensors and actuators Using Comsol Multiphysics or Coventor ware Software.

Course Outcomes:

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

- **CO1:** Describe the fundamentals of microtechnology 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 PDMS-based micro-biodevices and nanowires/rods for biomedical applications.
- **CO4:** Apply techniques for the characterizations of micro-bio-devices and nanowires/rods used for biomedical applications.

Reference Books:

1. Tai Ran Hsu, "MEMS and Microsystems, Design & Manufacture", John Wiley & Sons,2008, ISBN: 9780470083017.
2. Mohammed had-el-hak, "MEMS Introduction & Fundamentals", CRC Press, 2nd Edition, 2005. ISBN:9780849391378.
3. Harisingh Nalwa, "Nanoscience and Nanotechnology", American Scientific Publishers, Online Edition 2004. ISBN:1-58883-001-2.
4. Sergey Edward Lyshevski, "Nano & MEMS", CRC press, 2nd Edition, 2005. ISBN: 9780849328381.
5. Nadim Maluf, "An Introduction to MEMS Engineering" , Artech House Publishing, 2nd Edition, ISBN: 1-58053-590-9.
6. Steven S. Saliterman, "Fundamentals of BioMEMS and Medical Microdevices", CENGAGE Learning, India 1st Edition, ISBN-13: 978-0819459770.

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Practical

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Theory

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 question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M	M	L	L	L	_	M	_	L	M
CO2	M	H	M	M	M	H	_	M	_	L	M
CO3	L	L	M	H	H	L	_	M	_	L	M
CO4	M	M	M	M	H	H	_	M	_	L	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	L
CO2	M	L
CO3	M	L
CO4	M	L

SPEECH SIGNAL PROCESSING (Elective group-5)						
Course Code	**:**	**16MBS321**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Students are able to

1. To provide students with the knowledge of basic characteristics of speech signal in relation to production and hearing of speech by humans.
2. To describe basic algorithms of speech analysis common to many applications.
3. To give an overview of applications (recognition, synthesis, coding)
4. To inform about practical aspects of speech algorithms implementation.

UNIT–I	**09 Hrs**

Digital Models for Speech Signals: Process of Speech Production, The Acoustic Theory of speech production, Digital models for Speech signals.

Time Domain Models for Speech Processing: Time dependent processing of speech, Short time Energy and average magnitude, Short time average zero crossing rate, Speech vs. silence discrimination using energy and zero crossing.

UNIT– II	**10 Hrs**

Time Domain Models for Speech Processing: Pitch period estimation using parallel processing approach, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function.

Short Time Fourier Analysis: Introduction, Definitions and properties, Fourier transform interpretation, Linear filtering interpretation.

UNIT–III	**10 Hrs**

Digital Representations of the Speech Waveform: Sampling speech signals, Review of the statistical model for speech, Instantaneous quantization, Adaptive quantization, General theory of differential quantization, Delta modulation, Differential PCM, Comparison of systems.

UNIT–IV	**10 Hrs**

Linear Predictive Coding of Speech: Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Applications of LPC parameters.

UNIT–V	**09 Hrs**

Speech Synthesis: Principles of Speech synthesis, Synthesis based on waveform coding, Synthesis based on analysis synthesis method, Synthesis based on speech production mechanism, Synthesis by rule, Text to speech conversion.

Speech Recognition: Principles of Speech recognition, Speech period detection, Spectral distance measures, Structure of word recognition systems, Dynamic time warping (DTW), Word recognition using phoneme units.

Course Outcomes:

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

CO1: Understand the mechanisms of human speech production and how the articulation mode of different classes of speech sounds determines their acoustic characteristics.
CO2: Apply the basic concepts of methods for speech analysis and parametric representation of speech.
CO3: Analyse the algorithms for extracting parameters from the speech signal.
CO4: Create simple systems for realizing some multimedia applications with some basic audio and speech signal processing techniques.

Reference books:

1. "Digital Processing of Speech Signals", L R Rabiner and R W Schafer, Pearson Education 2009, ISBN: 978-81-317-0513-1.
2. "Digital Speech Processing, Synthesis and Recognition", Sadoaki Furui, Mercel Dekker, Second Edition, Taylor & Francis Publication, 2002, ISBN:0824704525, 9780824704520.
3. "Introduction to Data Compression", Khalid Sayood, Third Edition, Elsevier Publications, 2012, ISBN:978-0-12-415796-5.

Scheme of Continuous Internal Evaluation (CIE)
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)
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 question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M	M	M	H	M	-	M	M	-	M
CO2	M	M	M	M	H	M	-	M	M	-	M
CO3	M	M	M	M	H	M	-	M	M	-	M
CO4	H	M	M	M	H	M	-	M	M	-	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	M	H
CO3	M	H
CO4	-	H

IoT for Medical Applications
(Elective group-5)

Course Code	**:**	**16MBS322**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Students are able to:

1. Understand the fundamentals and importance of Internet of things.
2. Comprehend various factors about IoT which helps in developing applications for Biomedical Engineering.
3. Understand wearable sensor systems and their role in IoT.
4. Develop a biomedical application using IoT.

UNIT – I	**09 Hrs**

Introduction to IoT: putting Iot forward to the next level - IoT today, IoT tomorrow, potential success factors, IoT common definitions, case scenarios, functional view, application areas.

IoT Smart X Applications- Smart health platform, Smart energy, Smart home, Smart food, water, tracking and sensitivity.

UNIT – II	**09 Hrs**

IoT and Assistive Technologies for people with disabilities:

Basic building blocks of IoT architecture, & applications. 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	**09 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	**09 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 miniaturisation.

UNIT – V	**09 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 going through this course, the students will be able to,

CO1: Understand the fundamentals of internet of things.
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. Ovidiu Vermsan, Peter Friess, **"Internet of Things from research and Innovations to market development",** River publishers, ISBN: 978-87-93102-94-1, 2014.
2. Catarina Reiss, Marisa da silva maximiano, **"IoT and advanced applications in health care",** IGI Global medical information science reference, ISBN: 2237-9354.,2017.
3. Reference Journals & Conference publications - on all the relevant topics.

Scheme of Continuous Internal Evaluation (CIE)
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)
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 question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	L	L	-	-	-	L	M	M	M	-
CO2	L	L	L	-	-	-	L	L	L	L	-
CO3	M	L	L	-	-	-	L	L	M	L	-
CO4	H	M	M	-	-	-	L	M	M	L	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	M	H
CO3	M	H
CO4	-	H

VIRTUAL BIO INSTRUMENTATION (Elective group-6)						
Course Code	**:**	**16MBS331**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Students are able to:

1. Understand the difference between conventional and graphical programming, basics of data acquisition.
2. Develop ability for programming in LabVIEW using various data structures and program structures.
3. Plotting the graphs and charts for system monitoring, processing and controlling
4. Analyze the basics of data acquisition and learning the concepts of data acquisition with LabVIEW.

UNIT – I	**08 Hrs**

Graphical Programming Environment:

History of Virtual Instrumentation, Conventional and Graphical Programming. Introduction to LabVIEW, Components of LabVIEW, Owned and Free Labels, Tools and Other Palettes, Arranging Objects, Color Coding, Code Debugging, Context Help, Creating Sub-VIs.

UNIT – II	**10 Hrs**

Fundamentals of Virtual Instrumentation Programming:

FOR Loop, WHILE Loop, shift registers and feedback nodes, timing function. CASE structures, formula node, Sequence structures, composite data. Arrays and clusters, visual display types- graphs and charts. Local and Global variables.

State Machines: Introduction, Definition of State Machine, A Simple State Machine, Event Structures.

UNIT – III	**10 Hrs**

File Input/Output:

Introduction, File Formats, File I/O Functions, Path Functions, Sample VIs to Demonstrate File WRITE and READ Function.

String Handling: Introduction, String Functions, LabVIEW String Formats, Typical examples.

Basics of Data Acquisition: Introduction to data acquisition, Classification of Signals, Analog Interfacing Connecting signal to board, Analog Input/output techniques digital I/O, counters and timers.

UNIT – IV	**10 Hrs**

DAQ Hardware configuration: Introduction, Measurement and Automation Explorer, DAQ Assistants, Analysis Assistants.

Interfacing Instruments: GPIB and RS232, Handshaking, GPIB Interfacing, RS232C/RS485 Interfacing, Standard commands for Programmable Instruments, VISA.

Case Studies: myRiO, myDAQ.

Biomedical toolkit: ECG signal acquisition & feature extraction, EEG simulation, EMG power analysis.

UNIT – V	**10 Hrs**
Advanced Topics in LabVIEW: Fourier transforms Power spectrum, Correlation methods, windowing & filtering. Inter-Process Communication, Notifier, Queue, Semaphore, Data Sockets, Programmatically Printing Front Panels. **Simulation of systems using VI:** Image acquisition and processing.	
Course Outcomes: After going through this course the student will be able to: **CO1**: Explain the fundamentals of Virtual Instrumentation and data Acquisition. **CO2**: Apply the theoretical concepts to realize practical systems. **CO3**: Analyze and evaluate the performance of Virtual Instrumentation Systems. **CO4**: Create a VI system to solve real time problems using data acquisition.	
Reference books:	
1. Jovitha Jerome, "Virtual instrumentation Using LabVIEW", 4th Edition, PHI Learning Pvt.Ltd.,2010, ISBN:978-8120340305. 2. Sanjay Gupta & Joseph John, "Virtual Instrumentation Using LabVIEW", Tata Mc Graw Hill Publisher Ltd.,2 nd Edition, New Delhi, 2010, ISBN : 978-0070700284. 3. Jeffrey Travis, "LabVIEW for Everyone", Pearson, 3rd Edition, 2009,ISBN:978-81-317-2649-5. 4. Garry Johnson, Richard Jennings, LabVIEW Graphical Programming,4TH Edition McGraw Hill Professional, 17-Jul- 2006 ,ISBN No-978- 1259005336.	

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory

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 question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	-	L	-	M	-	-	-	M		L
CO2	M		L	L	M	L	-	-	M		L
CO3	M	-	L	-	M	L	-	-	M		L
CO4	H	L	L	L	H	L	-	-	M		L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	M
CO2	L	M
CO3	L	M
CO4	L	M

LASERS IN MEDICINE (Elective group-6)						
Course Code	**:**	**16MBS332**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Students are able to:

1. To Understand the basics of lasers and fiber optic system
2. To comprehend basic physical principles for use of laser in diagnostic and therapeutic medicine.
3. To study the optical properties of tissues, the effects of multiple scattering on light mathematical methods.
4. To learn the applications of absorption spectroscopy and factors that limit its accuracy in medicine.

UNIT- I	**09 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 Carbo dioxide lasers, safety with lasers.

UNIT- II	**09 Hrs**

Optical fibers and their properties: 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	**09 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 transillumination.

UNIT- IV	**09 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	09 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 going through this course, the student 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, CRC press, second edition, 2016, ISBN: 978-1-4822-6106-6.
2. Wilson and Hawkes, "Laser principles and applications", Prentice Hall of India, 7th Edition, 1987, ISBN: 978-0135237052.
3. Ronald W. Waynant (Editor), "Lasers in Medicine", CRC press, Jan 2002, ISBN 978-0849311468.
4. John.M. Senior, "Optical Fiber Communication – Principles and Practice", 3rd Edition, Pearson Prentice Hall of India, 2009, ISBN: 978-0-13-032681-2.
5. Abraham Katzir, "Lasers and optical fibres in medicine", Academic press, 1998, ISBN 0-12-401940-4.
6. David J. Goldberg, "Laser Dermatology -Pearls and Problems", Blackwell Publishing, 2008, ISBN-13: 978-1-4051-3420-0.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

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 question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	M	M	M	-	-	-	M	M	L	M
CO2	M	M	M	M	-	M	-	M	M	L	M
CO3	M	M	M	M	-	M	-	M	M	L	M
CO4	M	M	M	M	-	L	-	M	M	L	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	L
CO2	M	L
CO3	M	L
CO4	M	L

BIOMECHANICS (Elective group-7)						
Course Code	**:**	**16MBS341**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Students are able to:

1. Understand the properties of blood and the problems associated with extracorporeal blood flow.
2. Study the rheology of blood in microvessels to design artificial vessels.
3. Study the mechanics of the cardiovascular and respiratory system in order to design the prosthesis.
4. Analyze the dynamics of human movement and comprehend the biomechanical principles that relate to movement and communication disabilities.

UNIT – I **09 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 **09 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 **09 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 **10 Hrs**

Soft tissue mechanics:

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

UNIT-V **11 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 going through this 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. Y. C. Fung, Biomechanics- Mechanical properties of living tissues, Springer Verlag, Second edition, 2011, ISBN: 978-0-387-94384-8.
2. C. Ross Ethier, Craig A. Simmons, Introductory Biomechanics, Cambridge University Press, First edition, 2009, ISBN-13 :978-0-521-84112-2.
3. Joseph D Bronzino, The Biomedical Engineering Handbook, CRC press, Third Edition, 2006, ISBN: 0-8493-046-1.
4. Duane Knudson,Fundamentals of Biomechanics,Springer,Second edition,2007, ISBN 978-0-387-49311.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

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 question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	M	M	M	-	-	-	M	M	L	M
CO2	M	M	M	M	-	M	-	M	M	L	M
CO3	M	M	M	M	-	M	-	M	M	L	M
CO4	M	M	M	M	-	L	-	M	M	L	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	L
CO2	M	L
CO3	M	L
CO4	M	L

BIOMATERIALS AND ARTIFICIAL ORGANS (Elective group-7)						
Course Code	**:**	**16MBS342**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L: T: P: S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs**

Course Learning Objectives:

Students are able to:

1. To understand the fundamental science and engineering principles relevant to materials.
2. To understand the interactions at the interface of material and biological systems.
3. To study the physical, mechanical and biological properties of materials which can be implanted in the human body and their bio-compatibility.
4. To acquaint the student with modern artificial organs devices and methods used to partially support or completely replace pathological organ.

UNIT – I	**09 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	**10 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.

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	**09 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 going through this course, the student will be able to:

1. Understand the principles of material science engineering.

2. Apply core concepts of material science to solve engineering problems.
3. Analyze the structure and working of artificial organs.
4. Design a prototype model using the biomaterial.

Reference books:

1. Joseph D Bronzino, The Biomedical Engineering Handbook, Third Edition, 2006, CRC press, USA, ISBN: 0-8493-046-1.
2. Park J.B, "Biomaterials Science and Engineering", Plenum Press, 2009, ISBN: 978-1-4613-2769-1.
3. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill, 2013, ISBN: 978-0-0713-5637-4.
4. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, "Introduction to Biomedical Engineering", Elsevier, 2009, ISBN:978-0-1223-8662-6.
5. Sujata V. Bhatt, "Biomaterials", Narosa Publishing House, 2nd Edition, 2013, ISBN:978-0-7923-7058-1.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

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 question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	-	L	-	M	-	-	-	M	-	L
CO2	H		L	L	L	L	-	-	M	-	L
CO3	M	-	L	-	M	L	-	-	M	-	L
CO4	H	L	L	L	H	L	-	-	M	-	L

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	L	M
CO2	L	M
CO3	L	M
CO4	L	M

INTERNSHIP / INDUSTRIAL TRAINING						
Course Code	**:**	**16MBS35**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:6:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**30 min**

GUIDELINES FOR INTERNSHIP

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the process of applying engineering knowledge to produce product and provide services.

(2) Explain the importance of management and resource utilization

(3) Comprehend the importance of team work, protection of environment and sustainable solutions.

(4) Imbibe values, professional ethics for lifelong learning.

1) The duration of the internship shall be for a period of 8 weeks on full time basis between II semester final exams and beginning 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 or the M.Tech program in which the student has enrolled.

4) Students undergoing internship training are advised to use ICT tools such as skype to report their progress and submission of periodic progress reports to the faculty members.

5) Every student has to write and submit his/her own internship report to the designated faculty.

6) Students have to make a presentation on their internship activities in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the internship final report. However interim or periodic reports and reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.

7) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.

8) 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):

A committee comprising of the Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (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.

(1) Explanation of the application of engineering knowledge in industries 35%

(2) Ability to comprehend the functioning of the organization/ departments 20%

(3) Importance of resource management, environment and sustainability 25%

(4) Presentation Skills and Report 20%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	M	H	M	-	M	-	-	-	L	-
CO2	-	-	-	H	M	M	-	L	-	-	-
CO3	-	-	-	-	L	-	M	H	H	-	-
CO4	-	-	-	-	L	-	H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	-
CO2	L	L
CO3	-	M
CO4	M	H

GUIDELINES FOR INDUSTRIAL TRAINING

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the process of applying engineering knowledge to industrial products & processes
(2) Explain the importance of skilling, training and resource management.
(3) Comprehend the importance of team work, communication and sustainable solutions.
(4) Imbibe values, professional ethics for lifelong learning.

1) The duration of industrial training must be for a minimum of 1 week and maximum of 8 weeks on full time basis.

2) Industrial Training in which students pays a fee to the organization / industry will not be considered.

3) He/she can undergo training in one or more industry /organization.

4) The student must submit letters from the industry clearly specifying his / her name and the duration of the training provided by the company with authorized signatures.

5) Industrial training must be related to the field of specialization or the M.Tech program in which the student has enrolled.

6) Students undergoing industrial training are advised to use ICT tools such as skype to report their progress and submission of periodic progress reports to the faculty members.

7) Every student has to write and submit his/her own industrial training report to the designated faculty.

8) Students have to make a presentation on their industrial training in front of the departmental cmmittee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.

9) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.

10) The broad format of the industrial training report shall be as follows

- Cover Page
- Certificate from College
- Training Certificate from Industry / Organization
- Acknowledgement
- Executive Summary
- Table of Contents
- Chapter 1 - Profile of the Organization –Organizational structure, Products, Services,

Business Partners, Financials, Manpower, Societal Concerns, Professional Practices

- Chapter 2 – Details of the Training Modules
- Chapter 3 – Reflections – Highlight specific technical and soft skills that you acquired References & Annexure.

Course Outcomes:

After going through the industrial training, the student will be able to:

CO1: Understand the process of applying engineering knowledge to solve industrial problems

CO2: Develop skills through training relevant to industrial requirement

CO3: Communicate effectively and work in teams

CO4: Imbibe ethical practices and develop it as life skill.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (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.

(1) Explanation on the application of engineering knowledge	25%
(2) Ability to comprehend the importance of skilling and training	25%
(3) Importance of communication, professional ethics, sustainability	20%
(4) Oral Presentation and Report	30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	M	H	M	-	M	-	-	-	L	-
CO2	-	-	-	H	M	M	-	L	-	-	-
CO3	-	-	-	-	L	-	M	H	H	-	-
CO4	-	-	-	-	L	-	H	-	-	M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	-
CO2	L	L
CO3	-	M
CO4	M	H

GUIDELINES FOR INDUSTRIAL VISITS

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the role of industries and service organization in meeting the demands of the society.

(2) Explain the working of different industries and organizations with an engineering perspective.

(3) Comprehend the importance of team work, communication and sustainable solutions.

(4) Imbibe values, professional ethics for life long learning.

1) Student must visit a minimum of THREE organizations/industry. The duration of the visit per organization must be for ONE full day, during which he/she must comprehend the importance of organization structure, function of various departments, application of engineering knowledge, resource management, importance to environment and safety, professional ethics.

2) It is mandatory to visit ONE private multi-national company or public sector industry / organization, ONE medium-small enterprise and ONE rural based or NG organization.

3) The student must submit letter from the industry clearly specifying his / her name and the date of visit to the industry with authorized signatures.

4) Industrial visit must be related to the field of specialization or the M.Tech program in which the student has enrolled.

5) Every student has to write and submit his/her own report on each industrial visit and submit the report to the designated faculty advisor for evaluation.

6) A photograph outside the industry with the name and logo of the industry in the background along with the students and faculty members could be included in the report.

7) Students have to make a presentation on their industrial visit in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.

8) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.

9) The broad format of the industrial visit report shall be as follows

- Cover Page
- Certificate from College
- Acknowledgement
- Synopsis / Executive Summary

- Table of Contents
- Chapter 1 - Profile of the PSU or MNC – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices
- Chapter 2 – Profile of the SME – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices
- Chapter 3 - Profile of the NGO – must include Organizational structure, services, Manpower, Societal Concerns, Professional Practices
- Chapter 4 – Comparative Analysis of PSU/MNC – SME – NGO
- References & Annexure (Permission letters from the organizations for the visit & photographs)

Course Outcomes:

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

CO1: Classify the role of different industries and organization in addressing the needs of the society.

CO2: Explain the process of applying engineering knowledge in industries and organizations.

CO3: Describe the importance of communication and team work

CO4: Recognize the importance of practicing professional ethics and need for life skills.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (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.

(1) Explanation of the application of engineering knowledge in industries 25%

(2) Ability to comprehend the functioning of the organization/ departments 30%

(3) Importance of resource management, environment and sustainability 20%

(4) Presentation Skills and Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	-	M	H	M	-	M	-	-	-	L	-
CO2	-	-	-	H	M	M	-	L	-	-	-
CO3	-	-	-	-	L	-	M	H	H	-	-
CO4	-	-	-	-	L	-	H	-	-	M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	-
CO2	L	L
CO3	-	M
CO4	M	H

TECHNICAL SEMINAR						
Course Code	**:**	**16MBS36**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**SEE Marks**	**:**	**50**
Credits	**:**	**2**		**SEE Duration**	**:**	**30 min**

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the technological developments in their chosen field of interest

(2) Explain the scope of work and challenges in the domain area

(3) Analyze these engineering developments in the context of sustainability and societal concerns.

(4) Improve his/her presentation skills and technical report writing skills

GUIDELINES

1) The presentation will have to be done by individual students.
2) The topic of the seminar must be in one of the thrust areas with in-depth review and analysis on a current topic that is relevant to industry or on-going research.
3) The topic could be an extension or complementary to the project
4) The student must be able to highlight or relate these technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation.

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 would be carried out in TWO phases. The evaluation committee shall comprise of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (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.

Rubrics for Evaluation:

1) Topic – Technical Relevance, Sustainability and Societal Concerns 15%
2) Review of literature 25%
3) Presentation Skills 35%
4) Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	H	M	M	L	H	H	-	-	-	M
CO2	L	M	-	-	-	-	-	-	-	H	-
CO3	-	-	-	-	-	-	L	M	H	-	-
CO4	-	L	M	-	H	H	-	-	-	-	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	M	H
CO3	M	L
CO4	H	L

IV SEMESTER

MAJOR PROJECT						
Course Code	**:**	**16MBS41**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:52:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**26**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

The students shall be able to

1. Understand the method of applying engineering knowledge to solve specific problems.
2. Apply engineering and management principles while executing the project
3. Demonstrate good verbal presentation and technical report writing skills.
4. Identify and solve complex engineering problems using professionally prescribed standards.

GUIDELINES

1. Major project will have to be done by only one student in his/her area of interest.
2. Each student has to select a contemporary topic that will use the technical knowledge of their program of specialization.
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 three.
5. The project can be carried out on-campus or in an industry or an organization with prior approval from the Head of the Department.
6. The standard duration of the project is for 16 weeks, however if the guide and the evaluation committee of the department, after the assessment feel that the work is insufficient and it has to be extended, then the student will have to continue as per the directions of the guide and the committee.
7. It is mandatory for the student to present his/her work in one of the international conferences or publish the research finding in a reputed unpaid journal with impact factor.

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 lifelong learning.

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of: guide, two senior faculty members, one industry member and Head of the Department.

Phase	Activity	Weightage
I 5^{th} week	Synopsis, Preliminary report for the approval of selected topic along with literature survey, objectives and methodology.	20%

II 10th week	Mid-term progress review shall check the compliance with the objectives and methodology presented in Phase I, review the work performed.	40%
III 15th week	Oral presentation, demonstration and submission of project report. After this presentation, the student will have one week time to correct / modify his report to address the issues raised by the committee members.	40%

CIE Evaluation shall be done with marks distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing / analysis 25%
- Demonstration & Presentation 20%
- Report writing 20%

Scheme for Semester End Evaluation (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.

1. Brief write-up about the project 5%
2. Formulation of Project Objectives & Methodology 20%
3. Experiments / Analysis Performed; Results & Discussion 25%
4. Report 20%
5. Viva Voce 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	H	H	M	L	M	L	-	-	-	-
CO2	-	-	-	L	-	-	-	M	H	-	-
CO3	-	-	-	-	L	M	M	-	-	H	-
CO4	-	-	-	-	L	M	H	M	-	-	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	H	L
CO2	L	H
CO3	M	H
CO4	H	H

SEMINAR						
Course Code	**:**	**16MBS42**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**SEE Marks**		**50**
Credits	**:**	**2**		**SEE Duration**		**30 min**

Course Learning Objectives (CLO):

The students shall be able to:

1) Understand the technological developments in their chosen field of interest
2) Explain the scope of work and challenges in the domain area
3) Analyze these engineering developments in the context of sustainability, societal concerns and project management.
4) Improve his/her verbal presentation and report writing skills

GUIDELINES

1) The presentation will have to be done by individual students.
2) The topic of the seminar must be in one of the thrust areas with in-depth review and analysis on a current topic that is relevant to industry or on-going research.
3) The topic could be an extension or complementary to the project topic.
4) Topics could be in multidisciplinary areas and strongly address the technical design issues.
5) The student must be able to highlight or relate these technological developments with sustainability and societal relevance.
6) The students must mandatorily address legal, ethical issues as related to the topic of study.
7) The student shall make an attempt to perform financial / cost analysis or apply project management tools as related to his/her topic of study.
8) Each student must submit both hard and soft copies of the presentation.

Course Outcomes:

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

CO1: Identify topics that are relevant in the present context of the world and relate it to sustainability and societal relevance.

CO2: Perform literature/market/product survey and analyse information to the field of study.

CO3: Enhance presentation and report writing skills.

CO4: Develop creative thinking abilities.

Scheme of Continuous Internal Evaluation (CIE): Evaluation would be carried out in TWO phases. The evaluation committee shall comprise of TWO senior faculty members. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (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.

Rubrics for Evaluation:

- Topic – Technical Relevance, Sustainability and Societal Concerns 15%
- Literature Review 25%
- Presentation Skills 35%
- Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	-	H	M	M	L	H	H	-	-	-	M
CO2	L	M	-	-	-	-	-	-	-	H	-
CO3	-	-	-	-	-	-	L	M	H	-	-
CO4	-	L	M	-	H	H	-	-	-	-	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	H	L
CO2	M	H
CO3	M	L
CO4	H	L