



# **Vidyalankar Institute of Technology**

*(Autonomous Institute Affiliated to the University of Mumbai)*

## **Scheme and Detailed Syllabus**

**of**

**Third Year**

**in**

**Bachelor of Engineering**

**in**

**Biomedical Engineering**

(Curriculum of REV- 2019 'C' Scheme of UoM)

With effect from Academic Year 2022-23

**Program Structure for Third Year Biomedical Engineering**  
**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**

**Semester V**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC501	Biomedical Instrumentation – I	3	--	3	--	3
BMC502	Digital Signal Processing	3	--	3		3
BMC503	Microcontrollers and Embedded Systems	4	--	4	--	4
BMC504	Medical Imaging – II	3	--	3	--	3
BMDO501X	Department Optional Course – 1	3	--	3	--	3
BML501	Biomedical Instrumentation – I Laboratory	--	2	--	1	1
BML502	Digital Signal Processing Laboratory	--	2	--	1	1
BML503	Microcontrollers and Embedded Systems Laboratory	--	2	--	1	1
BML504	Professional Communication and Ethics – II	--	2*+2	--	2	2
BMM501	Mini Project – 2 A	--	4\$	--	2	2
<b>Total</b>		<b>16</b>	<b>14</b>	<b>16</b>	<b>07</b>	<b>23</b>

**Evaluation Scheme for Third Year Biomedical Engineering**

**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**

**Semester V**

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC501	Biomedical Instrumentation – I	20	30	50	100
BMC502	Digital Signal Processing	20	30	50	100
BMC503	Microcontrollers and Embedded Systems	20	30	50	100
BMC504	Medical Imaging – II	20	30	50	100
BMDO501X	Department Optional Course – 1	20	30	50	100
BML501	Biomedical Instrumentation – I Laboratory	25		25	50

BML502	Digital Signal Processing Laboratory	25		25	50
BML503	Microcontrollers and Embedded Systems Laboratory	25		25	50
BML504	Professional Communication and Ethics – II	25		25	50
BMM501	Mini Project – 2 A	25			25
<b>Total</b>		<b>225</b>	<b>150</b>	<b>350</b>	<b>725</b>

Total Contact Hours/week :29

Total Credit : 23

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

\* Theory class to be conducted for full class and \$ indicates workload of Learner (Not Faculty), students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1 hour per week per four groups.

**Sem. V: Department Optional Course –**

- BMDO5011: Principles of Communication Engineering
- BMDO5012: Very Large Scale Integration
- BMDO5013: Tissue Engineering

**Program Structure for Third Year Biomedical Engineering**  
**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**  
**Semester VI**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC601	Biomedical Instrumentation – II	3	--	3	--	3
BMC602	Biomedical Digital Image Processing	3	--	3		3
BMC603	Data Analysis in Healthcare	3	--	3	--	3
BMC604	Biomechanics, Prosthetics and Orthotics	3	1	3	--	4
BMDO601X	Department Optional Course – 2	3	--	3	--	3
BML601	Biomedical Instrumentation – II Laboratory	--	2	--	1	1
BML602	Biomedical Digital Image Processing Laboratory	--	2	--	1	1
BML603	Data Analysis in Healthcare Laboratory	--	2	--	1	1
BML604	Patient- care Automation Laboratory	--	4	--	2	2
BMM601	Mini Project – 2 B	--	4 <sup>\$</sup>	--	2	2
<b>Total</b>		<b>15</b>	<b>15</b>	<b>15</b>	<b>07</b>	<b>23</b>

**Evaluation Scheme for Third Year Biomedical Engineering**  
**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**  
**Semester VI**

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC601	Biomedical Instrumentation – II	20	30	50	100
BMC602	Biomedical Digital Image Processing	20	30	50	100
BMC603	Data Analysis in Healthcare	20	30	50	100
BMC604	Biomechanics, Prosthetics and Orthotics	20+25(T)	30	50	125

BMDO601X	Department Optional Course – 2	20	30	50	100
BML601	Biomedical Instrumentation – II Laboratory	25		25	50
BML602	Biomedical Digital Image Processing Laboratory	25		25	50
BML603	Data Analysis in Healthcare Laboratory	25		25	50
BML604	Patient-care Automation Laboratory	25			25
BMM601	Mini Project – 2 B	25		25	50
<b>Total</b>		<b>250</b>	<b>150</b>	<b>350</b>	<b>750</b>

Total Contact Hours/week :30

Total Credit : 23

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

**Sem. VI: Department Optional Course – 2**

- BMDO6011: Nuclear Medicine
- BMDO6012: Advanced Embedded Systems
- BMDO6013: Telemedicine

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC501	Biomedical Instrumentation – I	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC501	Biomedical Instrumentation – I	20	30	50	100

Course Code	Course Name	Credits
<b>BMC501</b>	<b>Biomedical Instrumentation - I</b>	<b>03</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>• To understand the basic principles and working of diagnostic and therapeutic equipment.</li> <li>• To develop skills enabling Biomedical Engineers to serve the health care industry</li> <li>• To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.</li> </ul>	
<b>Course Outcome</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• Explain the principles of various analytical instruments used in hospital and laboratories.</li> <li>• Demonstrate knowledge about various blood cell counting systems and blood gas analyzers.</li> <li>• Demonstrate knowledge about various automated drug delivery systems.</li> <li>• Explain the basics of pulmonary function analyzer, ventilators, and demonstrate the use of ventilation therapy and anesthesia machine.</li> <li>• Explain the basic principle and working of hemodialysis machine.</li> </ul>	

Module	Contents	Hours
<b>1.</b>	<p><b>Basic principle, working and technical specifications of Analytical Instruments</b></p> <ol style="list-style-type: none"> <li>1. Colorimeter</li> <li>2. Spectrophotometer</li> <li>3. Auto Analyzer</li> <li>4. Principles of Electrophoresis apparatus</li> <li>5. Principles of Chromatography</li> <li>6. ELISA concepts (direct and indirect), reader &amp; washer.</li> </ol>	<b>10</b>

2.	<b>Basic principle, working and technical specifications of Blood cell counter</b> (Coulter and Pico-scale) <b>Blood Gas Analyzer</b>	<b>04</b>
3.	<b>Automated drug delivery systems</b> Infusion pumps, components of drug infusion systems, syringe and peristaltic pumps.	<b>04</b>
4.	<b>Basic principle and working of Pulmonary Function Analyzer</b> Respiration measurement technique: lung volume and capacities, spirometry, nitrogen washout, helium dilution,	<b>06</b>
5.	<b>Basic principle and working of Ventilators</b> Artificial ventilation, ventilator terms and its types, modes of ventilators, classification of ventilators, pressure volume flow and time diagrams. microprocessor controlled ventilator <b>Basic principle and working of Anesthesia Machine</b> Need for anesthesia, anesthesia machine: gas supply, flow and delivery system vapor delivery and humidification and patient breathing capnography.	<b>10</b>
6.	<b>Basic principle, working and technical specifications of Hemodialysis machine</b> Basic principle of dialysis, different types of dialyzer membranes, portable dialysers and various monitoring circuits.	<b>05</b>

#### Books Recommended:

##### *Text books:*

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

##### *Reference books:*

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC502	Digital Signal Processing	3	--	3		3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC502	Digital Signal Processing	20	30	50	100

Course Code	Course Name	Credits
<b>BMC502</b>	<b>Digital Signal Processing</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To build a strong base in signal and image processing through algorithm development.</li> <li>To develop competency in logical thinking, computer programming and knowledge application.</li> <li>To train and motivate for higher education and research in order to make contribution to state of the art health care for all.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand the fundamental techniques and applications in digital processing of bio-signals.</li> <li>Understand circular and linear convolution and their implementation using Z-transform and DFT.</li> <li>Understand and implement efficient computational techniques like FFT.</li> <li>Design FIR and IIR filters by different methods.</li> </ul>	

Module	Contents	Hours
1.	Basic elements of Digital Signal Processing, concepts of frequency in analog and digital signals, sampling theorem, discrete time signals and systems their properties, Z-transform and properties, Linear & circular convolution, Correlation, DTFT.	08
2.	Introduction to DFT, Properties of DFT, DIT and DIF, FFT algorithms, use of FFT in linear filtering, discrete cosine transforms.	08
3.	Review of design of analog Butterworth and Chebyshev filters, frequency transformation in analog domain, design of IIR digital filters using impulse invariance method, design of digital filters using bilinear transformation.	06



<b>4.</b>	Structure of FIR filters, linear phase filters, filter design using window technique, frequency sampling techniques, finite word length effects in digital filters, realisation of FIR & IIR filters, direct, cascade and parallel forms.	<b>06</b>
<b>5.</b>	Introduction to digital signal processors, architecture, features, addressing formats, functional mode, introduction to commercial processors, applications.	<b>03</b>
<b>6.</b>	Preliminaries, biomedical signals (ECG, EMG, EEG) origin & dynamics, statistical preliminaries, time domain filtering (synchronized averaging, moving average), time domain filtering (moving average filter to integration-derivative based operator), Frequency domain filtering (notch Filter), optimal filtering: Wiener filter, adaptive filtering, selecting appropriate filter	<b>08</b>

#### Text books:

1. Digital signal processing Principles Algorithms and Application – Proakis & Manolakis – Third edition PHI
2. Digital Signal Processing – Sanjit K. Mithra Tata Mc-graw Hill
3. Digital Signal Processing – S. Salivahanan, C. Gnanapriya, Tata McGraw Hill

#### Reference Books:

1. Digital signal processing – A.V. Oppenheim and R.W. Schafer - PHI
2. Understanding Digital Signal Processing – Richard G. Lyons - Pearson Publication
3. Biomedical Digital Signal Processing -- Willis J. Tompkins -- EEE, PHI, 2004
4. R M Rangayyan "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC503	Microcontrollers and Embedded Systems	4	--	4	--	4

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC503	Microcontrollers and Embedded Systems	20	30	50	100

Course Code	Course Name	Credits
<b>BMC503</b>	<b>Microcontrollers and Embedded Systems</b>	<b>04</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To provide the knowledge about the 8051 microcontroller architecture and programming so that the learners can apply the this knowledge to design microcontroller-based application</li> <li>To make learners aware of the basics of embedded systems and real time operating system</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Explain the fundamentals of embedded systems</li> <li>Apply the knowledge of 8051 Microcontroller architecture</li> <li>Apply the knowledge of 8051 programming in assembly and C language</li> <li>Design and analyse 8051 interfacing with external memory, input/output devices and PC</li> <li>Apply the concept of serial communication protocols</li> <li>Explain the concept of Real Time Operating Systems (RTOS)</li> </ul>	

Module	Contents	Hours
1.	<b>Embedded systems:</b> Definition, characteristics, constraints; processor embedded into a system; embedded hardware units and devices in a system; embedded software in a system; examples of embedded systems; design process in embedded system; classification of embedded systems.	<b>04</b>

2.	<b>8051 Microcontroller Architecture:</b> Introduction: Von Neumann and Harvard architecture, CISC and RISC architecture, comparison of microprocessor and microcontrollers; 8051 hardware block diagram, pin diagram, CPU timing and machine cycles; 8051 programmer model, SFRs and PSW; 8051 Memory organization, parallel I/O ports, integrated peripherals such as timers/counters, serial port, interrupt structure; 8051 Power saving modes.	12
3.	<b>8051 Microcontroller Programming:</b> 8051 assembly language programming process, programming tools; 8051 assembly language: addressing modes, instruction set; assembly language programming and embedded C programming.	12
4.	<b>8051 Microcontroller Interfacing:</b> 8051 interfacing (and related programs) with - external memory, keypad, LED, LCD, ADC and sensors, DAC, relays and d.c. motors, stepper motor; Interfacing 8051 with pc using RS232.	12
5.	<b>Serial Communication Protocols:</b> Operation of serial port, programming for asynchronous serial communication; Serial communication using the 'I2C', SPI; Introduction to USB & CAN bus.	06
6.	<b>Real Time Operating Systems (RTOS):</b> Introduction to RTOS concept, RTOS functions, System timer, process/tasks and task states; RTOS scheduler and algorithms; interrupt latency, interrupt response time as performance metrics; example of small RTOS based systems.	06

### Books Recommended:

#### Text books:

1. The 8051 microcontrollers by Kenneth J Ayala, Cengage Learning.
2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C by M A Mazidi, J G Mazidi and R D McKinlay, Pearson Education.
3. Using MCS-51 Microcontroller by Han-Way Huang, Oxford University Press.
4. 8051 microcontroller: Hardware, Software & Applications by V Udayashankara, M Mallikarjunaswamy, McGraw Hill Education.
5. Embedded Systems-Architecture, Programming and Design, Rajkamal, Tata McGraw Hill.

#### Reference Books:

1. Embedded Realtime Systems Programming by Sriram Iyer and Pankaj Gupta, Tata McGraw Hill.
2. Embedded Microcomputer Systems - Real Time Interfacing by Valvano, Cengage Learning.
3. Embedded System Design: A Unified Hardware/Software Introduction by Frank Vahid, Toney Givargis - John Wiley Publication.
4. An Embedded Software Primer by David E. Simon - Pearson Education.

### NPTEL/Swayam Course:

Course: Microprocessors and Microcontrollers (Video) by Prof. Santanu Chattopadhyaya from IIT Kharagpur.

<https://nptel.ac.in/courses/108/105/108105102/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMC504	Medical Imaging – II	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC504	Medical Imaging – II	20	30	50	100

Course Code	Course Name	Credits
<b>BMC504</b>	<b>Medical Imaging - II</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities.</li> <li>To keep the learners abreast with the technological developments in the field of Medical Imaging.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand use of Ultrasound in medicine, distinguish various ultrasonic display system, understand the construction and operation of the ultrasonic transducer.</li> <li>Understand the Doppler effect and clinical applications of Doppler Techniques.</li> <li>Describe working principle and physics involved in Magnetic Resonance Imaging (MRI)</li> <li>Understand the hardware of MRI Machine, Spin echo Imaging, Pulse sequence, image reconstruction, resolution and SNR, Biological effects, and clinical applications.</li> <li>To understand the basic principle of Magnetic Resonance Spectroscopy.</li> <li>To understand principle and working of Endoscopy and Thermography systems and its clinical applications.</li> </ul>	

Module	Contents	Hours
1	<b>Ultrasound Imaging</b> Introduction, production and characteristics of ultrasound, interaction of ultrasound with matter. ultrasound transducers and instrumentation. real time ultrasound.	08
2	<b>Doppler Ultrasound</b> Doppler effect, continuous wave and pulsed wave doppler system, 2D-echo, clinical applications.	04
3	<b>Physics of MRI</b> Magnetic dipole moments, relaxation parameters, spin echo, magneticfield gradients, slice selection, phase and frequency encoding.	06
4	<b>Magnetic Resonance Imaging</b> Hardware: magnets, gradient coils, RF coils, spin echo imaging, inversionrecovery pulse sequence, image reconstruction, resolution and factors affecting signal-to-noise. safety considerations and biological effects of MRI, clinical applications.	09
5	<b>Magnetic Resonance Spectroscopy (MRS)</b> Basic principle of MRS, metabolites studied, STEAM and PRESS pulse sequences, chemical shift imaging, single-voxel and multivoxel MRS, water suppression techniques.	06
6	<b>Endoscopy and Thermography</b> Working principle, equipment, and its applications.	06

#### Books Recommended:

##### Textbooks:

1. *Christensen's Physics of Diagnostic Radiology*, Thomas S. Curry, James E. Dowdey, Robert C.Murry. Wolters Kluwer, Fourth Edition.
2. *Medical Imaging Physics*, William R. Hendee, E. Russell Ritenour. Wiley, Fourth Edition.
3. *Physics of Diagnostic Imaging*, David Dowsett, Patrick A Kenny, R Eugene Johnston. CRC Press,Second Edition.

##### Reference Books:

1. *Biomedical Technology and Devices*, James Moore, George Zouridakis. CRC Press, SecondEdition.
2. *The Biomedical Engineering Handbook*, Joseph D. Bronzino, CRC Press, Second Edition.
3. *MRI: The Basics*, Ray H. Hashemi, William G. Bradley, Christopher J. Lisanti. Lippincott Williams& Wilkins, Second Edition.

##### NPTEL/Swayam Links:

Medical Image Analysis, Dr. Debdoot Sheet, Indian Institute of Technology, Kharagpur Course Link: <https://nptel.ac.in/courses/108/105/108105091/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMDO501X	Department Optional Course – 1	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO5011	<b>Principles of Communication Engineering</b>	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO501X</b>	<b>Principles of Communication Engineering</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To provide concepts, principles and techniques used in analog and digital communications.</li> <li>To cover a range of digital modulation techniques which are frequently used in modern communication systems.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Demonstrate concept of electronic communication system with effect of noise and modelling of noise</li> <li>Have in depth knowledge of amplitude modulation and understand the AM transmitters and Receiver system with characteristics.</li> <li>Exhibit basic operation of FM transmitter and receiver with types, analysis, advantages and disadvantages</li> <li>Understand and compare the different types of Analog pulse modulation techniques</li> <li>Understand the different types of Digital pulse modulation techniques with merits and demerits</li> <li>Understand and compare different types of digital transmission techniques and multiplexing techniques</li> </ul>	

Module	Contents	Hours
1.	<p><b>Introduction to communication system and noise:</b></p> <ul style="list-style-type: none"> <li>Elements of communication system, types of communication system</li> <li>Noise definition, types, signal to noise ratio, noise factor, noise figure, noise temperature</li> </ul>	<b>04</b>
2.	<p><b>Amplitude Modulation Transmission and Receivers:</b></p> <ul style="list-style-type: none"> <li>Definition, mathematical analysis of AM wave, different types of AM, spectrum, bandwidth,</li> <li>AM transmitter: high and low level AM transmitter, DSB and SSB transmitter (any one method)</li> <li>AM receiver: characteristics: sensitivity, selectivity, fidelity, double spotting, Image frequency and its rejection, dynamic range, super-heterodyne receiver, double conversion receiver</li> </ul>	<b>07</b>

3.	<b>Frequency Modulation Transmission and Receivers:</b> <ul style="list-style-type: none"> <li>• Principles of FM waveform, spectrum, bandwidth</li> <li>• FM generation: direct and indirect FM transmitter</li> <li>• Principles of AFC, effect of noise in FM, noise triangle, pre-emphasis and de-emphasis</li> <li>• FM Receivers: block diagram</li> <li>• Types: simple slope detector, balanced slope detector, Foster Seeley discriminator, ratio detector, quadrature detector</li> <li>• Capture effect in FM receivers, difference between AM and FM system</li> </ul>	10
4.	<b>Analog Pulse Modulation Techniques:</b> <ul style="list-style-type: none"> <li>• Analog modulation techniques: PAM, PWM, PPM – generation, detection, advantages, disadvantages.</li> </ul>	05
5.	<b>Digital Pulse Modulation Techniques:</b> <ul style="list-style-type: none"> <li>• Digital pulse modulation techniques: PCM, DPCM, DM and ADM–generation, detection, advantages and disadvantages.</li> </ul>	05
6.	<b>Digital Transmission Techniques and Multiplexing:</b> <ul style="list-style-type: none"> <li>• Digital transmission types: ASK, FSK, PSK - generation, detection, advantages and disadvantages.</li> <li>• Multiplexing techniques: concept of multiplexing, FDM, TDM, hierarchy, applications, advantages and disadvantages.</li> </ul>	08

#### Books Recommended:

##### *Text books:*

1. Electronic communication system – Wayne Tomasi, Pearson Education
2. Electronic communication system – Roy Blake, Thomson Learning
3. Electronic communication system - Kennedy and Devis, TMH

##### *Reference Books:*

1. Digital and Analog communication system – Leon W Couch, Pearson Education
2. Principles of communication system – Taub and Schilling ,TMH

1. Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO5012	Very Large Scale Integration (Abbreviated asVLSI)	03	--	--	03	--	--	03

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO5012	Very Large-Scale Integration	20	30	50	100

Course Code	Course Name	Credits
BMDO5012	Very Large-Scale Integration	03
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To make the learner aware of fundamental concepts of Hardware Description Languages</li> <li>To make learner study working of MOSFET</li> <li>To make learner know the CMOS Circuits.</li> <li>The learner should be able to know the MOSFET fabrication processes</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to ...</b></p> <ul style="list-style-type: none"> <li>To describe hardware description language used to model circuits.</li> <li>To develop some basic digital circuits using HDL</li> <li>To analyze the physics of MOS devices.</li> <li>To compare characteristics of various inverter circuits</li> <li>To compare the fabrication technology used in IC fabrication and how system clocking is designed.</li> <li>To design layouts for various digital gates applying the design rules</li> </ul>	

ModuleNo.	Contents	Hours
1.	<b>Physics of MOSFET</b> MOSFET, threshold voltage, linear and saturated operation, FET capacitance, Scaling of MOS circuits, types of scaling and limitations of scaling-short channel and hot electron effect.	05
2.	<b>MOSFET Inverters:</b> MOS Transistors, MOS transistor switches, Basic MOS inverter and its working, types of MOS invertors viz active and passive load nMOS inverters, CMOS inverter, voltage transfer characteristics, noise immunity and noise margins.	05



3.	<b>Silicon Semiconductor Technology:</b> Wafer processing, mask generation, oxidation, epitaxial growth, diffusion, ion implantation, photolithography, etching, metallization, basic nMOS and pMOS processes. Latch up in CMOS and CMOS using twin tub process.	07
4.	<b>Introduction to VLSI Clocking and System Design:</b> Clocking: CMOS clocking styles, Clock generation, stabilization and distribution. Low power CMOS Circuits: Various components of power dissipation in CMOS, limits on low power design, low power design through voltage scaling.	06
5.	<b>Design rules and Layout</b> NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Interlayer contacts, butting and buried contacts, stick diagrams, layout of inverter, NAND and NOR gates. Design of basic VLSI circuits, design of circuits like multiplexer, decoder, flip flops, using MOS circuits.	08
6.	<b>Hardware Description Language</b> Introduction to VHDL hardware description language, core features of VHDL, data types, different modeling styles and architectures of VHDL, Combinational and Sequential Logic design using VHDL	08

### Books Recommended:

#### Text Books:

1. CMOS Digital Integrated Circuits, Kang, Tata McGraw Hill Publications, Third Edition
2. Introduction to VLSI design, E. D. Fabricus, McGraw Hill Publications, 1990
3. Basic VLSI Design, D.A. Pucknell and Eshraghian, Prentice Hall of India, 2005
4. Digital Design Principles and Practices, John F Wakerly, Prentice Hall of India, Third edition
5. Circuit Design with VHDL, Volnei A. Pedroni, Prentice Hall of India, 2009
6. Introduction to VLSI Circuits and Systems- John P. Uyemura, Wiley

#### Reference Books:

1. VHDL Programming by Examples, Douglas Perry, McGraw Hill Publications, 2008
2. Principles of CMOS VLSI Design : A Systems Perspective, Neil H.E. Weste, Kamran Eshraghian Addison Wesley Publications, Second edition, 1993

1. Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO5013	Tissue Engineering (Abbreviated as TE)	03	--	--	03	--	--	03

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO5013	Tissue Engineering	20	30	50	100

Course Code	Course Name	Credits
BMDO5013	Tissue Engineering	03
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand the basics and terminologies of tissue engineering.</li> <li>Learn importance of stem cells in tissue engineering</li> <li>To understand the basic concepts of cell culture</li> <li>To understand applications of tissue engineering in medical field</li> </ul>	
<b>Course Outcome</b>	<b>Learner will be able...</b> <ul style="list-style-type: none"> <li>To get acquainted with cellular responses</li> <li>To understand role of extracellular matrix in tissue engineering</li> <li>To understand cell characteristics.</li> <li>To understand tissue culture and cryopreservation techniques.</li> <li>To understand the selection of various biomaterials for tissue engineering</li> <li>To understand tissue engineering applications</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction to Tissue Engineering:</b> Fundamentals of stem cell tissue engineering, mechanical forces on cells, cell adhesion, cell migration, inflammatory and immune responses to tissue, cell death- biological description of apoptosis, tissue types.	07
2.	<b>Extracellular Matrix:</b> Structure, function, components, synthesis of the collagens, The ECM - cell binding and long-term contact.	05
3.	<b>Measurement of cell characteristics:</b> Cell morphology, cell number and viability, cell-fate processes, cell motility, cell function.	05
4.	<b>Cell and tissue culture:</b> Types of tissue culture, media, culture environment and maintenance of cells in -vitro, cryopreservation. problems with the culture, organ culture.	06
5.	<b>Biomaterials in Tissue Engineering:</b> Biodegradable polymers and polymer scaffold processing. biomimetic materials, nanocomposite scaffolds, gene therapy, bioreactors for tissue engineering.	06

<b>6.</b>	<b>Tissue Engineering – regeneration:</b> Skin, bone marrow, nervous system, muscle, ligaments and cartilage, cardiac muscles - myocardial tissue engineering, strategies to deliver stem cells to the damaged site.	<b>10</b>
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### Books Recommended:

#### Text books:

1. Bernhard O. Palsson, Sangeeta N. Bhatia, "Tissue Engineering", Pearson Prentice Hall Publishers, 2009.
2. Joseph D. Bronzino, "The Biomedical Engineering Handbook", CRC Press LLC, 2006.
3. John P. Fisher, Antonios G. Mikos and Joseph D. Bronzino, "Tissue Engineering", CRC Press LLC, 2007.
4. W. W. Minuth, R. Strehl and K. Schumacher, "Tissue Engineering- Essentials for Daily Laboratory Work", Wiley-VCH Verlag GmbH & Co. KGaA, 2005.
5. Daniel Eberli, "Tissue Engineering for Tissue and Organ Regeneration", InTech, 2011.

#### Reference books:

1. Raphael Gorodetsky, Richard Schäfer, "Stem Cell Based Tissue Repair", RSC Publishing, 2011.
2. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2004, Academic Press, 2004.
3. R. Lanza, J. Gearhart et. al. (Eds), "Essential of Stem Cell Biology", Academic press, 2009
4. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenerative Medicine", Artech House, INC Publications, 2008.
5. Naggy N. Habib, M.Y. Levicar, L. G. Jiao and N. Fisk, "Stem Cell Repair and Regeneration", volume-2, Imperial College Press, 2007.
6. Cato T. Laurencin, Lakshmi S. Nair, "Nanotechnology and Tissue engineering - The Scaffold", CRC Press, 2015.
7. Meyer, U., Meyer, Th., Handschel, J., Wiesmann, H.P., "Fundamentals of Tissue Engineering and Regenerative Medicine" Springer, 2009.
8. Lanza RP, Langer R, Vacanti J. "Principles of Tissue Engineering", Third edition. Academic Press. 2007.

### NPTEL/Swayam Links:

Course 1: Tissue Engineering

<https://nptel.ac.in/courses/102/106/102106081/>

Course 2: Tissue Engineering

<https://nptel.ac.in/courses/102/106/102106036/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BML501	Biomedical Instrumentation – I Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML501	Biomedical Instrumentation – I Laboratory	25		25	50

**Syllabus: Same as that of (BMC501) Biomedical Instrumentation- -I (BMI-I)**

**List of Experiments: (Any Seven)**

1. Selection of wavelength for colorimeter and spectrophotometer
2. Find out the concentration of unknown sample using colorimeter and spectrophotometer
3. Design and implementation of 5V, 1A regulated power supply
4. Design and implementation of temperature controller circuit for hemodialysis machine
5. Design and implementation of pulse width modulator
6. Demonstration of ventilators
7. Demonstration of anesthesia machine
8. Calculations of lung volumes and capacities
9. Industry / hospital visit to be conducted.

Any other experiment based on syllabus which will help learner to understand topic/concept. Group

presentation on the latest technology in hospitals based on the topics covered in the syllabus.

## Assessment:

### In Semester Assessment (ISA)

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

## Books Recommended:

*Text books:*

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements: Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

*Reference books:*

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites

**Oral examination will be based on suggested practical list and entire syllabus.**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BML502	Digital Signal Processing Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML502	Digital Signal Processing Laboratory	25		25	50

Course Code	Course Name	Credits
<b>BML502</b>	<b>Digital Signal Processing Laboratory</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To build a strong base in signal and image processing through algorithm development.</li> <li>To develop competency in logical thinking, computer programming and knowledge application.</li> <li>To train and motivate for higher education and research in order to make contribution to state of the art health care for all.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Understand the fundamental techniques and applications in digital processing of bio-signals.</li> <li>Understand circular and linear convolution and their implementation using Z-transform and DFT.</li> <li>Understand and implement efficient computational techniques like FFT.</li> <li>Design FIR and IIR filters by different methods.</li> </ul>	

**Syllabus: Same as that of BMC502 Digital Signal Processing (Abbreviated as DSP)**

**List of Experiments (using Matlab / C / Labview / python / other platform)**

1. Basics of programming
2. Simulations of standard signals
3. Concept of aliasing
4. Linear convolution circular convolution
5. Discrete Fourier Transform (DFT )
6. Design and simulation of FIR filter
7. IIR filters using Butterworth approximation
8. IIR filter using Chebyshev approximation
9. Pan-Tompkin algorithm for R-wave detection

## Assessment:

### In Semester Assessment (ISA)

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

### Text books:

1. Digital signal processing Principles Algorithms and Application – Proakis & Manolakis – Third edition PHI
2. Digital Signal Processing – Sanjit K. Mithra Tata Mc-graw Hill
3. Digital Signal Processing – S. Salivahanan, C. Gnanapriya, Tata McGraw Hill

### Reference Books:

1. Digital signal processing – A.V. Oppenheim and R.W. Schafer - PHI
2. Understanding Digital Signal Processing – Richard G. Lyons - Pearson Publication
3. Biomedical Digital Signal Processing -- Willis J. Tompkins -- EEE, PHI, 2004
4. R M Rangayyan "Biomedical Signal Analysis: A case Based Approach", IEEE Press, John Wiley & Sons. Inc, 2002

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BML503	Microcontrollers and Embedded Systems Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML503	Microcontrollers and Embedded Systems Laboratory	25		25	50

Course Code	Course Name	Credits
<b>BML503</b>	<b>Microcontrollers and Embedded Systems Laboratory</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>Give the students skills in both simulation and practical implementation of the basic building blocks of 8051 microcontroller-based applications including timers/counters, PWM generation, I/O techniques and requirements, DC motors, stepper motors, keyboard, display device and serial communications</li> <li>Give students skills in 8051 microcontroller programming.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Design different programs using C compilers for 8051 controller</li> <li>Design and develop 8051 embedded C programs for timer based applications</li> <li>Design and develop 8051 embedded C programs for control of DC motors and stepper motors</li> <li>Design and develop 8051 embedded C programs for interfacing keyboard and display device</li> <li>Design and develop 8051 embedded C programs for interfacing with the PC</li> </ul>	

**Syllabus: Same as that of BMC503 Microcontrollers and Embedded Systems (Abbreviated as MES).**

**List of Laboratory Experiments:**

**Any eight experiments to be performed in hardware mode and/or software simulation mode.**

1. To demonstrate basic I/O toggling and interrupts of 8051.
2. To generate precise delay and trigger pulses using 8051 timer.



3. To generate waveform and perform PWM using 8051 timer.
4. To interface 8051 with relay and DC motor (using H bridge) – demonstration through basic I/O toggling.
5. To control the speed of DC motor through PWM based MOSFET switching.
6. To interface 8051 with the stepper motor.
7. To interface 8051 with the seven-segment display.
8. To interface 8051 with the keyboard.
9. To interface 8051 with PC using UART and RS232 standard.

**Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.**

### **In Semester Assessment (ISA)**

ISA shall consist of minimum 8 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

### **Books Recommended:**

#### ***Textbooks:***

1. The 8051 microcontrollers by Kenneth J Ayala, Cengage Learning.
2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C by M A Mazidi, J G Mazidi and R D McKinlay, Pearson Education.
3. Using MCS-51 Microcontroller by Han-Way Huang, Oxford University Press.
4. 8051 microcontroller: Hardware, Software & Applications by V Udayashankara, M Mallikarjunaswamy, McGraw Hill Education.
5. Embedded Systems-Architecture, Programming and Design, Rajkamal, Tata McGraw Hill.

### **Reference Books:**

1. Embedded Realtime Systems Programming by Sriram Iyer and Pankaj Gupta, Tata McGraw Hill.
2. Embedded Microcomputer Systems - Real Time Interfacing by Valvano, Cengage Learning.
3. Embedded System Design: A Unified Hardware/Software Introduction by Frank Vahid, Toney Givargis - John Wiley Publication.
4. An Embedded Software Primer by David E. Simon - Pearson Education.

### **NPTEL/Swayam Course:**

Course: Microprocessors and Microcontrollers (Video) by Prof. Santanu Chattopadhyaya from IIT Kharagpur.  
<https://nptel.ac.in/courses/108/105/108105102/>

**Practical exam consists of performance of any one practical from the conducted experiments within this semester**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BML504	Professional Communication and Ethics – II	--	2*+2	--	2	2

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML504	Professional Communication and Ethics – II	25		25	50

Course Code	Course Name	Credits
<b>BML504</b>	<b>Professional Communication &amp; Ethics - II</b>	<b>02</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To discern and develop an effective style of writing important technical/business documents.</li> <li>• To investigate possible resources and plan a successful job campaign.</li> <li>• To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.</li> <li>• To develop creative and impactful presentation skills.</li> <li>• To analyse personal traits, interests, values, aptitudes and skills.</li> <li>• To understand the importance of integrity and develop a personal code of ethics.</li> </ul>	

<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• plan and prepare effective business/ technical documents which will inturn provide solid foundation for their future managerial roles.</li> <li>• strategize their personal and professional skills to build a professional image and meet the demands of the industry.</li> <li>• emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.</li> <li>• deliver persuasive and professional presentations.</li> <li>• develop creative thinking and interpersonal skills required for effective professional communication.</li> <li>• apply codes of ethical conduct, personal integrity and norms of organizational behaviour.</li> </ul>
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<b>Module</b>	<b>Contents</b>	<b>Hours</b>
<b>1</b>	<p><b>ADVANCED TECHNICAL WRITING :PROJECT/PROBLEMBASED LEARNING (PBL)</b></p> <p><b>1.1 Purpose and Classification of Reports:</b> <b>Classification on the basis of:</b></p> <ul style="list-style-type: none"> <li>• Subject Matter (Technology, Accounting, Finance, Marketing, etc.)</li> <li>• Time Interval (Periodic, One-time, Special)</li> <li>• Function (Informational, Analytical, etc.)</li> <li>• Physical Factors (Memorandum, Letter, Short &amp; Long)</li> </ul> <p><b>1.2. Parts of a Long Formal Report:</b></p> <ul style="list-style-type: none"> <li>• Prefatory Parts (Front Matter)</li> <li>• Report Proper (Main Body)</li> <li>• Appended Parts (Back Matter)</li> </ul> <p><b>1.3. Language and Style of Reports</b></p> <ul style="list-style-type: none"> <li>• Tense, Person &amp; Voice of Reports</li> <li>• Numbering Style of Chapters, Sections, Figures, Tables and Equations</li> <li>• Referencing Styles in APA &amp; MLA Format</li> <li>• Proofreading through Plagiarism Checkers</li> </ul> <p><b>1.4. Definition, Purpose &amp; Types of Proposals</b></p> <ul style="list-style-type: none"> <li>• Solicited (in conformance with RFP) &amp; Unsolicited Proposals</li> <li>• Types (Short and Long proposals)</li> </ul> <p><b>1.5. Parts of a Proposal</b></p> <ul style="list-style-type: none"> <li>• Elements</li> <li>• Scope and Limitations</li> <li>• Conclusion</li> </ul> <p><b>1.6. Technical Paper Writing</b></p> <ul style="list-style-type: none"> <li>• Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and</li> </ul>	<b>06</b>

	<p>References)</p> <ul style="list-style-type: none"> <li>• Language and Formatting</li> <li>• Referencing in IEEE Format</li> </ul>	
2	<p><b>EMPLOYMENT SKILLS</b></p> <p><b>2.1. Cover Letter &amp; Resume</b></p> <ul style="list-style-type: none"> <li>• Parts and Content of a Cover Letter</li> <li>• Difference between Bio-data, Resume &amp; CV</li> <li>• Essential Parts of a Resume</li> <li>• Types of Resume (Chronological, Functional &amp; Combination)</li> </ul> <p><b>2.2 Statement of Purpose</b></p> <ul style="list-style-type: none"> <li>• Importance of SOP</li> <li>• Tips for Writing an Effective SOP</li> </ul> <p><b>2.3 Verbal Aptitude Test</b></p> <ul style="list-style-type: none"> <li>• Modelled on CAT, GRE, GMAT exams</li> </ul> <p><b>2.4. Group Discussions</b></p> <ul style="list-style-type: none"> <li>• Purpose of a GD</li> <li>• Parameters of Evaluating a GD</li> <li>• Types of GDs (Normal, Case-based &amp; Role Plays)</li> <li>• GD Etiquettes</li> </ul> <p><b>2.5. Personal Interviews</b></p> <ul style="list-style-type: none"> <li>• Planning and Preparation</li> <li>• Types of Questions</li> <li>• Types of Interviews (Structured, Stress, Behavioural, Problem Solving &amp; Case-based)</li> <li>• Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual</li> </ul>	06
3	<p><b>BUSINESS MEETINGS</b></p> <p><b>a. Conducting Business Meetings</b></p> <ul style="list-style-type: none"> <li>• Types of Meetings</li> <li>• Roles and Responsibilities of Chairperson, Secretary and Members</li> <li>• Meeting Etiquette</li> </ul> <p><b>3.2. Documentation</b></p> <ul style="list-style-type: none"> <li>• Notice</li> <li>• Agenda</li> <li>• Minutes</li> </ul>	02
4	<p><b>TECHNICAL/ BUSINESS PRESENTATIONS</b></p> <p><b>a. Effective Presentation Strategies</b></p> <ul style="list-style-type: none"> <li>• Defining Purpose</li> <li>• Analysing Audience, Location and Event</li> <li>• Gathering, Selecting &amp; Arranging Material</li> <li>• Structuring a Presentation</li> <li>• Making Effective Slides</li> <li>• Types of Presentations Aids</li> <li>• Closing a Presentation</li> <li>• Platform skills</li> </ul> <p><b>b. Group Presentations</b></p>	02

	<ul style="list-style-type: none"> <li>• Sharing Responsibility in a Team</li> <li>• Building the contents and visuals together</li> <li>• Transition Phases</li> </ul>	
<b>5</b>	<p><b>INTERPERSONAL SKILLS</b></p> <p><b>a. Interpersonal Skills</b></p> <ul style="list-style-type: none"> <li>• Emotional Intelligence</li> <li>• Leadership &amp; Motivation</li> <li>• Conflict Management &amp; Negotiation</li> <li>• Time Management</li> <li>• Assertiveness</li> <li>• Decision Making</li> </ul> <p><b>5.2 Start-up Skills</b></p> <ul style="list-style-type: none"> <li>• Financial Literacy</li> <li>• Risk Assessment</li> <li>• Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)</li> </ul>	<b>08</b>
<b>6</b>	<p><b>CORPORATE ETHICS</b></p> <p><b>6.1 Intellectual Property Rights</b></p> <ul style="list-style-type: none"> <li>• Copyrights</li> <li>• Trademarks</li> <li>• Patents</li> <li>• Industrial Designs</li> <li>• Geographical Indications</li> <li>• Integrated Circuits</li> <li>• Trade Secrets (Undisclosed Information)</li> </ul> <p><b>6.2 Case Studies</b></p> <ul style="list-style-type: none"> <li>• Cases related to Business/ Corporate Ethics</li> </ul>	<b>02</b>

#### List of assignments:

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal
3. Meeting Documentation
4. Writing a Technical Paper/ Analysing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

#### Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end-semester presentation based on the book report.

#### Assessment:

## **In Semester Assessment (ISA)**

ISA shall consist of minimum 8 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

## **INTERNAL ORAL - 25 MARKS**

**Oral Examination will be based on a GD & the Project/Book Report presentation.**

Group Discussion : 10 marks

Project presentation

Individual Presentation : 10 Marks

Group Dynamics : 5 Marks

### **Books Recommended:**

#### **Textbooks and Reference books:**

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., & Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011). *Personal development for life and work*. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) *Technical Communication, Principles and Practice*. Oxford University Press
7. Archana Ram (2018) *Place Mentor, Tests of Aptitude For Placement Readiness*. Oxford University Press
8. Sanjay Kumar & PushpLata (2018). *Communication Skills a workbook*, New Delhi: Oxford University Press.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
BMM501	Mini Project – 2 A	--	4\$	--	2	2

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMM501	Mini Project – 2 A	25			25

<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To acquaint with the process of identifying the needs and converting it into the problem.</li> <li>To familiarize the process of solving the problem in a group.</li> <li>To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.</li> <li>To inculcate the process of self-learning and research.</li> </ul>
<b>Course Outcome</b>	<p><b>Learner will be able to:</b></p> <ul style="list-style-type: none"> <li>Identify problems based on societal /research needs.</li> <li>Apply Knowledge and skill to solve societal problems in a group.</li> <li>Develop interpersonal skills to work as member of a group or leader.</li> <li>Draw the proper inferences from available results through theoretical/ experimental/simulations.</li> <li>Analyse the impact of solutions in societal and environmental context for sustainable development.</li> <li>Use standard norms of engineering practices</li> <li>Excel in written and oral communication.</li> <li>Demonstrate capabilities of self-learning in a group, which leads to life long learning.</li> <li>Demonstrate project management principles during project work.</li> </ul>

### Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solutions and select the best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. Mini Project 2 in semesters V and VI.
- However, based on the individual student or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

### **Guidelines for Assessment of Mini Project:**

#### **In Semester Assessment (ISA)**

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
 

○ Marks awarded by guide/supervisor based on log book	10
○ Marks awarded by review committee	10
○ Quality of Project report	05

**Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.**

#### **One-year project:**

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  - First shall be for finalisation of problem
  - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

#### **Half-year project:**

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem



- Proposed final solution
- Procurement of components/systems
- Building prototype and testing
- Two reviews will be conducted for continuous assessment,
- First shall be for finalisation of problem and proposed solution
- Second shall be for implementation and testing of solution.

### Assessment criteria of Mini Project.

**Mini Project** shall be assessed based on following criteria;

1. Quality of survey/ need identification
  2. Clarity of Problem definition based on need.
  3. Innovativeness in solutions
  4. Feasibility of proposed problem solutions and selection of best solution
  5. Cost effectiveness
  6. Societal impact
  7. Innovativeness
  8. Cost effectiveness and Societal impact
  9. Full functioning of working model as per stated requirements
  10. Effective use of skill sets
  11. Effective use of standard engineering norms
  12. Contribution of an individual's as member or leader
  13. Clarity in written and oral communication
- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
  - In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

### Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

**Mini Project** shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communicate

**Semester – VI**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC601	Biomedical Instrumentation – II	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC601	Biomedical Instrumentation – II	20	30	50	100

Course Code	Course Name	Credits
<b>BMC601</b>	<b>Biomedical Instrumentation-II</b>	<b>03</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand the basic principles and working of different Biomedical monitoring systems.</li> <li>To develop skills enabling Biomedical Engineers to serve the health care industry</li> <li>To develop core competency and skill in the field of Biomedical Engineering to design and develop new health care systems.</li> </ul>	
<b>Course Outcome</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Provide a better understanding about various bioelectrical signal recorders and patient safety along with greater emphasis on health care equipment and the advanced technologies such as Telemetry and Telemedicine.</li> <li>Demonstrate the principles of electronics used in designing various biomedical monitoring equipment.</li> <li>Understand the basic principles and working of audiometry equipments and hearing aids</li> <li>Provide a better understanding about foetal and neonatal monitoring systems.</li> <li>Acquire the ability to explain the various blood flow and cardiac output measurement devices.</li> </ul>	

Module	Contents	Hours
1.	<b>Basic principle, working and technical specifications of</b> ECG, EMG and EEG machines, LEAD configurations, 10-20 electrode system measuring techniques for EOG, ERG and phonocardiography, <b>Patient Safety:</b> Electric shock hazards, leakage currents, safety codes for electro-medical equipment.	08
2.	<b>Arrhythmia and Patient monitoring:</b> Cardiac arrhythmias, Stress test measurement, ambulatory monitoring instruments such as holter monitor. <b>Basics of Telemetry, Multi-channel Telemetry.</b>	08
3.	<b>Basic principle and working of Patient Monitoring Systems</b> Measurement of heart rate, pulse rate, blood pressure, temperature and respiration rate, apnea detector. Heart rate variability measurement. <b>Point of care devices and their design considerations for homecare devices:</b> glucometer.	08
4.	<b>Basic principle and working of Audiometers and hearing aid</b> Basic audiometer, pure tone and speech audiometer, evoked response audiometry, introduction to hearing aids and cochlear implants.	05
5.	<b>Basic principle and working of Foetal and Neonatal Monitoring System</b> Cardiotocograph, methods of monitoring of foetal heart rate, monitoring of labour activity, incubator and infant warmer, non-stress test monitoring.	05
6.	<b>Basic principle and working of Blood flowmeters</b> Electromagnetic, ultrasonic, NMR and laser doppler flowmetry, <b>Measurement of Cardiac Output</b> Indicator dilution, dye dilution and thermal dilution techniques.	05

#### Books Recommended:

##### Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements: Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

##### Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
2. Various Instruments Manuals.
3. Various internet websites.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC602	Biomedical Digital Image Processing	3	--	3		3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC602	Biomedical Digital Image Processing	20	30	50	100

Course Code	Course Name	Credits
<b>BMC602</b>	<b>Biomedical Digital Image Processing</b>	<b>03</b>
Course Objectives	<ul style="list-style-type: none"> <li>To be able to think about applying different Image processing techniques on a given image.</li> <li>To know the fundamental concepts of a digital image processing techniques</li> <li>To be able to analyze problem and design algorithms to solve the problems.</li> </ul>	
Course Outcomes	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description.</li> <li>Analyze images in the spatial domain.</li> <li>Analyze images in the frequency domain through the Fourier transform.</li> <li>Apply the concepts of morphology, representation and description on images.</li> <li>Design and implement with MATLAB/C/Python algorithms for digital image processing.</li> </ul>	

Module	Contents	Time
1.	<b>Basics of Image Processing:</b> Image acquisition, processing, communication, display; electromagnetic spectrum; elements of visual perception - structure of the human eye, image formation in the eye, brightness adaptation and discrimination, image formation model, uniform and non-uniform sampling, quantization, image formats.	06
2.	<b>Image Enhancement:</b> Spatial domain - point processing techniques, histogram processing, neighbourhood processing, frequency domain techniques, 2D-DFT, properties of 2D-DFT, low pass, high pass, noise removal, homomorphic filters, basics of colour image processing.	09
3.	<b>Image Segmentation:</b> Basic relationships between pixels, neighbours, adjacency, connectivity, regions, boundaries, distance measures; detection of discontinuities, point, line and edges, edge linking, Hough transform, thresholding based segmentation, region-based segmentation.	06

4.	<b>Image Transforms &amp; Image Compression:</b> DFT, FFT, DCT, DST, Hadamard, Walsh, Haar, basis functions and basis images, introduction to wavelet transform, fundamentals of image compression models, lossless compression, RLE, Huffman, LZW and arithmetic coding techniques, lossy compression - IGS coding, transformcoding, JPEG, JPEG 2000.	08
5.	<b>Morphology, Representation and Description:</b> Dilation, erosion, open, close, hit-or-miss, boundary extraction, region filling, thinning and thickening; chain codes, polygonal approximations, signatures; fourier descriptors, moments.	04
6.	<b>Feature Recognition and Classification:</b> Object recognition and classification, connected components labelling, features, statistical classification, structural/syntactic classification, applications in medical image analysis	06

#### Text books:

1. Digital Image Processing, Gonzalez and Woods - Pearson Education.
2. Fundamentals of Digital Image Processing, A.K. Jain – P.H.I.
3. Digital Image Processing and Analysis, Chanda Majumder - Printice Hall India.

#### Reference Books:

1. Digital Image Processing for Medical Applications, Geoff Dougherty, Cambridge UniversityPress, 2009..
2. Digital Image Processing, William Pratt - John Wiley.

#### NPTEL/Swayam Course:

Course:

Digital Image Processing - NPTEL Lecture Videos by Prof. P.K. Biswas from IIT Kharagpur.

<http://www.nptelvideos.com/course.php?id=541>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC603	Data Analysis in Healthcare	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC603	Data Analysis inHealthcare	20	30	50	100

Course Code	Course Name	Credits
<b>BMC603</b>	<b>Data Analysis in Healthcare</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To cover basic concepts and theory related to statistics.</li> <li>• To focus on various statistical abilities such as analysis of variance, hypothesis testing, estimation, etc.</li> </ul>	
<b>Course Outcomes</b>	<p>The learner will be able to :</p> <ul style="list-style-type: none"> <li>• Understand the basic techniques and nomenclatures used for statistical analysis of data</li> <li>• Describe the importance of normalizing data</li> <li>• Apply statistical methods to sample data</li> <li>• Analyze data using parametric statistical methods</li> <li>• Develop a strong foundation for designing algorithms for computation.</li> <li>• Design statistical models separately for parametric and non-parametric analysis.</li> </ul>	

Module	Contents	Hours
1	<b>Descriptive statistics, probability and sampling distributions:</b> Frequency distribution, measures of central tendency, measures of dispersion, basic probability and Bayes theorem, Binomial, Poisson and normal distributions, sampling distributions of sample mean, difference between two sample means, sample proportions and difference between two sample proportions	09
2	<b>Estimation:</b> Confidence intervals for population mean, difference between two population means, population proportion, difference between two population proportions, t-distribution, variance of normally distributed population, ratio of variances of two normally distributed populations, determination of sample size for estimating mean and proportions	06
3	<b>Hypothesis testing:</b> Type – I and II errors, hypothesis testing for population mean, difference between two population means, population proportions, difference between two population proportions, population variance and ratio of two population variances, power of test	06
4	<b>Analysis of variance:</b> Completely randomized design, randomized complete block design, repeated measures design, factorial experiment, regression and correlation, simple linear regression, correlation model, correlation coefficient, multiple regression, multiple correlation	06
5	<b>Chi square distribution and analysis of frequency:</b> Chi-square distribution and properties, test of goodness of fit, independence and homogeneity of data	06
6	<b>Non-parametric analysis:</b> Distribution free tests such as one sample sign test, rank sum test, Mann-Whitney U-test, Kruskal-Wallis test, cluster analysis, data mining methods	06

#### Books Recommended:

#### Text Books:

1. Biostatistics – A foundation for analysis in health sciences by Wayne W. Daniel, Seventh edition, Wiley India
2. Fundamentals of mathematical statistics by S. C. Gupta and V. K. Kapoor, second edition, Sultan Chand Publisher
3. Probability and statistics for engineers by J. Ravichandran, Wiley /India
4. Research Methodology Methods and Techniques by C. R Kothari and Gaurav Garg, Fourth Edition, New Age international publishers.

#### Reference Books:

1. Biostatistics – How it works by Steve selvin, Pearson education
2. An Introduction to Biostatistics by Sunder Rao and J. Richard, Third Edition, Prentice Hall of India
3. Probability and Statistics by Schaum's series

#### NPTEL/Swayam Course:

Course:

Introduction to Data Analytics by Prof. Nandan Sundarsanam – IIT-M and Prof. B. Ravindran – IIT-M

<https://nptel.ac.in/noc/courses/noc16/SEM2/noc16-mg06/>

Data analytics with Python by Prof. A. Ramesh - IIT Roorkee

<https://nptel.ac.in/courses/106/107/106107220/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC604	Biomechanics, Prosthetics and Orthotics	3	1	3	--	4

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMC604	Biomechanics, Prosthetics and Orthotics	20+25(T)	30	50	125

Course Code	Course Name	Credits
<b>BMC604</b>	<b>Biomechanics, Prosthetics and Orthotics</b>	<b>03</b>
Course Objectives	<ul style="list-style-type: none"> <li>Recall the general characteristics, mechanical properties of bone and tissues.</li> <li>Analyze the forces at joints for various static and dynamic human activities; analyze the stresses and strains in biological tissues.</li> <li>Understand principles used in designing orthoses and prostheses</li> <li>Study different materials used for orthoses and prosthesis.</li> </ul>	
Course Outcomes	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Explain the basic principles of Biomechanics</li> <li>Explain the mechanical behavior of Biological Tissues</li> <li>Explain about various joints and its movements</li> <li>Explain the techniques adopted for analyzing joint movements.</li> <li>Explain the general principles followed while designing Orthoses and prosthesis.</li> <li>Explain the applications of various Prosthetic and Orthotic devices.</li> </ul>	

Module	Contents	Time
	<b>BIOMECHANICS</b>	
1.	<b>Force system:</b> Classification of force system, equilibrium of force system, principle of biomechanics	<b>02</b>
2.	<b>Tissue Biomechanics:</b> Direct shear, bending and torque actions and the corresponding stresses and strains in biological tissues. stress relaxation and creep. Bone structure & composition, mechanical properties of bone, biomechanical evaluation of bone using three points and four points. Biomechanics of connective tissues (skin, tendon, ligaments, etc.) covering structure function, and physiological factors.	<b>10</b>
3.	<b>Movement Biomechanics:</b> Study of joints and movements, anatomical levers, gait analysis, gait cycle and gait parameters	<b>04</b>
4.	<b>Joint analysis:</b> Instrumentation for gait analysis: measurement devices-footswitches, instrumented walkway, motion analysis - Selspot, goniometers, joint monitoring sensors and joint monitoring parameters	<b>05</b>



	<b>PROSTHETICS AND ORTHOTICS</b>	
<b>5.</b>	<b>Principles in designing orthoses and prostheses:</b> Principles of three point pressure, total contact, partial weight bearing.	<b>05</b>
<b>6.</b>	<b>Classification in prosthetics and orthotics:</b> Lower extremity orthoses and prostheses, upper extremity orthoses and prostheses, spinal orthoses.	<b>13</b>

**Tutorials:** Eight tutorials are to be conducted from the below list.

1. Components of biomechanics
2. Role of biomechanics in exercises
3. Biomechanics and body movements
4. Gait cycle
5. Evaluation of gait parameters
6. Orthotic devices associated with sports injuries
7. Advancements in materials used for orthotic devices
8. Prosthetic rehabilitation
9. Advancements in materials used for prosthetic devices

**Text books:**

1. Basic Biomechanics- Susan J. Hall, MC Graw Hill.
2. Basics of Biomechanics" by Dr. Ajay Bahl and others
3. Basic Biomechanics of the Musculoskeletal System, M. Nordin, V. Frankel
4. Human Limbs and their substitutes – Atlas, C. V. Mosby
5. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
6. American Atlas of Orthopedics: Orthotics, C. V. Mosby
7. Biomechanics - Prof Ghista (Private Publication UAE)
8. Biomechanics – By White and Puyator (Private Publication UAE)

**Reference Books:**

1. Introductory Biomechanics: from cells to tissues by Ethier and Simmons
2. Biomechanics: Mechanical properties of living tissues by Y. C. Fung

**NPTEL/Swayam Course:**

1. Assistive Devices, Prosthesis and Orthosis, NPTEL Lecture Video by Dr Sujatha Srinivasan, IIT Madras.  
<http://www.digimat.in/nptel/courses/video/112106248/L47.html>
2. Mechanics of Human Movement, Swayam, Lecture Video by Dr Sujatha Srinivasan, IIT Madras.  
[https://onlinecourses.nptel.ac.in/noc21\\_me52/preview](https://onlinecourses.nptel.ac.in/noc21_me52/preview)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMDO601X	Department Optional Course – 2	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO6011	<b>Nuclear Medicine</b>	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO6011</b>	<b>Nuclear Medicine</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To enable the students to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment.</li> <li>To keep the students abreast with the technological developments in the field of nuclear medicine.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learners will be able to</b></p> <ul style="list-style-type: none"> <li>Explain the essential physics of nuclear medicine such as concepts of radioactivity, its measurement, interaction with matter and radionuclide production.</li> <li>Apply the principles of physics to understand working of various detectors and counting systems.</li> <li>Study principle of operation of different scanning system and their quality control function.</li> <li>Explain various Emission Tomography Techniques along with their Clinical Applications.</li> <li>Explain various aspects of radiation safety.</li> <li>Explain concept of radionuclide therapy and the function of radiotherapy equipment.</li> </ul>	

Module	Content	Hours
1.	<p><b>Basics of Nuclear Physics:</b> Radioactivity, radioactive decay law, radioactive decay processes, decay scheme of Mo-99. Units of radioactivity measurement, interaction of radiation with matter</p> <p><b>Production of Radionuclide:</b> Methods of radionuclide production: nuclear reactor, medical cyclotron &amp; radionuclide generators</p>	<b>09</b>
	<p>Spectra of commonly used radio nuclides e.g Tc-99m, Cs-137.</p> <p><b>Radiopharmaceuticals:</b> ideal radiopharmaceutical, methods of radio labelling</p>	

2.	<p><b>Detectors in Nuclear Medicine &amp; Counting and Measuring System:</b> Gas filled detectors, scintillation detectors and solid-state detectors, scintillation counting system, gamma ray spectrometry, radionuclide dose calibrator, properties of detectors.</p> <p><b>In Vitro Techniques (Brief Description):</b> Introduction, single and double isotope method, radioimmunoassay, RIA counting system, liquid scintillation counting system, RIA applications.</p>	07
3.	<p><b>In Vivo Techniques:</b> General principle, uptake monitoring system, rectilinear scanner, gammacamera fundamentals, position circuitry and working, computer interface, performance parameters, quality control functions</p>	06
4.	<p><b>Emission Tomography Techniques and Clinical Applications:</b> Introduction, principles and applications of SPECT, principles and applications of PET, system performance parameters and quality control functions.</p> <p><b>Introduction to Hybrid Modalities:</b> PET/CT, SPECT/CT</p> <p><b>Clinical Applications</b> Clinical applications of PET, SPECT and hybrid modalities in cardiology, neurology and oncology.</p>	07
5.	<p><b>Radiation Safety:</b> Natural &amp; artificial radiation exposure, external &amp; internal radiation hazard, methods of minimizing external exposure, methods of preventing internal exposure, evaluation of external &amp; internal hazard, biological effects of radiation, radioactive waste management.</p>	06
6.	<p><b>Radionuclide Therapy:</b> Choice of a radionuclide in therapeutic nuclear medicine, radiotherapy equipment: cobalt unit, proton beam therapy</p>	04

### Books Recommended:

#### Text Books:

1. J. Harbert and A.F.G. Rocha, *Textbook of Nuclear medicine*, Second Edition, Lea & Febiger.
2. B.R. Bairy, Balvinder Singh, N.C. Rathod and P.V. Narurkar, *Handbook of Nuclear medicine Instruments*, Tata McGraw – Hill.
3. Gopal B. Saha, *Fundamentals of Nuclear Pharmacy*, Springer Science + Business Media
4. Ramesh Chandra, *Introductory Physics of Nuclear Medicine*, Lea & Febiger.
5. Simon R. Cherry, James A. Sorenson and Michael E. Phelps, *Physics in Nuclear Medicine*, Saunders, an imprint of Elsevier Inc.
6. Janet F. Eary and Winfried Brenner, *Nuclear Medicine Therapy*, informa healthcare

#### Reference Books:

1. William R. Hendee, *Medical Radiation Physics*, Year Book Medical Publishers
2. G. Hine, *Instrumentation of Nuclear medicine*, Academic Press
3. Glenn F. Knoll, *Radiation Detection & Measurement*, John Wiley & Sons.

### NPTEL/Swayam Links:

Course 1: Nuclear Science and Engineering, Dr. Santanu Gosh, Indian institute of Technology, Delhi

<https://nptel.ac.in/courses/115/102/115102017/>

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMDO601X	Department Optional Course – 2	3	--	3	--	3

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO6012	<b>Advanced Embedded Systems</b>	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO6012</b>	<b>Advanced Embedded Systems</b>	<b>03</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To impart the hardware and software concepts of Embedded System.</li> <li>To introduce the students with Real Time Operating System.</li> <li>To implement the embedded design, ARM Cortex M3 Microcontroller is covered in detail.</li> </ul>	
<b>Course Outcomes</b>	Learner will be able to: <ul style="list-style-type: none"> <li>Explain the fundamentals of embedded systems</li> <li>Understand the characteristics and hardware of embedded system.</li> <li>Understand the software used for an embedded system.</li> <li>Understand interprocess communication.</li> <li>Understand the usage of the development and debugging tools.</li> <li>Explain the concept of Real Time Operating Systems (RTOS) using practical cases.</li> </ul>	

Module	Contents	Hours
<b>1.</b>	<b>ARM Cortex M3:</b> Overview of ARM family, comparison of RISC and CISC architectures. Cortex-M3 architecture, pipelining, BUS interfaces Programmers' model: register set, program status register, operation modes and states. Memory system and memory protection unit (MPU). Exceptions, interrupt architecture: Nested vectored interrupt controller, power management, watchdog timer and systick timer.	<b>08</b>

2.	<b>Introduction to Embedded Systems and Embedded Hardware:</b> characteristics and design metrics of embedded system, challenges in embedded system design, embedded processors, co-processors and hardware accelerators. Processor performance enhancement: pipelining and superscalar architecture. Types of memories and buffers, sensors (optical encoders, resistive sensors) and actuators (solenoid valves, relay/switch, opto-couplers). Power supply considerations in embedded systems: linear and switching voltage regulators, low power features, sleep mode, brown-out detection.	06
3.	<b>Embedded Software – RTOS 01:</b> Features of RTOS, advantages of RTOS, hard and soft real time systems, selecting an RTOS, Kernel architectures and features. Task/Processes and threads, task states, multitasking, interrupt latency. Context Switching: Cooperative multi-tasking and pre-emptive multi-tasking. Task Scheduler: FIFO, round robin, rate-monotonic scheduling, earliest- deadline first scheduling, fault-tolerant scheduling	08
4.	<b>Embedded Software – RTOS 02:</b> Inter-process communication: Semaphores and signals, shared memory communication, message based communication. Memory management, file systems, device management (device drivers), I/O and communications management. Event timers, task synchronization, priority inversion, deadlock. Software design methodologies: UML, FSM, DFG. Evaluating and optimizing operating system performance: response-time calculation, interrupt latency, time-loading, memory loading.	08
5.	<b>FreeRTOS:</b> Study of Kernel structure of FreeRTOS, functions for initialization, task creation, inter-task communication and resource management, memory management. System integration, testing and debugging methodology: Embedded product design life-cycle (EDLC), Hardware-software co-design testing & debugging: Boundary-scan/JTAG interface concepts, black-box testing, white-box testing.	05
6.	<b>Case studies:</b> Chocolate vending machine, washing machine, automotive systems, auto-focusing digital camera, air-conditioner.	04

### Books Recommended:

#### Text books:

1. Embedded Systems Architecture Programming and Design: Raj Kamal, Tata McGraw Hill
2. Software Design for Real-Time Systems: Cooling, J E, *published by* Chapman and Hall in 1991 ...ISBN 978-0-442-31174-2
3. Embedded System Design: A unified Hardware/software Introduction by Frankvahid/TonyGivargis, Wiley India Edition
4. Real-Time Systems Design and Analysis: An Engineer's Handbook: Laplante, Phillip A by IEEEpress, Wiley-Interscience, A John Wiley and Sons Inc, Publications
5. Embedded / Real-Time Systems: Concepts, Design and Programming Black Book, New ed(MISL-DT)

#### Reference Books:

1. Embedded Realtime Systems Programming by Sriram Iyer and Pankaj Gupta, Tata McGraw Hill.
2. Dreamteach Software team, Programming for Embedded Systems, AVR 8515 manual
3. Bruce Powel Douglas, "Real-Time UML, Second Edition: Developing Efficient Object for Embedded Systems, 2nd edition ,1999, Addison-Wesley
4. An Embedded Software Primer by David E. Simon - Pearson Education, 2003

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMDO601X	Department Optional Course – 2	3	--	3	--	3

Course Code	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMDO6013	Telemedicine	20	30	50	100

Course Code	Course Name	Credits
<b>BMDO6013</b>	<b>Telemedicine</b>	<b>03</b>
Course Objectives	<ul style="list-style-type: none"> <li>• Learn the key principles for telemedicine and e-health care.</li> <li>• Understand telemedicine technology.</li> <li>• Know telemedicine standards, mobile telemedicine, and its applications.</li> </ul>	
Course Outcomes	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>• Explain the basic principles of healthcare in telemedicine</li> <li>• Discuss the role of telecommunication in Healthcare</li> <li>• Describe various Tele-medicine standards.</li> <li>• Explain the different Components of tele-radiology system</li> <li>• Discuss the various applications of telemedicine</li> </ul>	

Module	Contents	Hours
1.	<b>Introduction to Telemedicine:</b> Historical perspective and evolution of telemedicine, tele health, tele care, components of telemedicine system, global and indian scenario, ethical and legal aspects of telemedicine, safety and regulatory issues, laws governing telemedicine.	<b>07</b>
2.	<b>Telemedicine Technology:</b> Principles of multimedia – text, audio, video, data, data communications and networks, PSTN, POTS, ANT, ISDN, internet, air/wireless communications: GSM satellite, and micro wave, modulation techniques, integration and operational issues, communication infrastructure for telemedicine, LAN and WAN technology, satellite communications, mobile hand held devices and mobile communication, internet technology, video and audio conferencing, clinical data - local and centralized	<b>06</b>
3.	<b>Telemedicine Standards:</b> Data security and standards: encryption, cryptography, mechanisms of encryption, phases of encryption. Protocols: TCP/IP, ISO-OSI, standards to be followed DICOM, HL7, H.320 series (video phone based ISBN) T.120, H.324 (video phone based PSTN), Video conferencing, real-time telemedicine integrating doctors / hospitals, clinical laboratory data, radiological data, and other clinically significant biomedical data,	<b>06</b>
	administration of centralized medical data, security and confidentiality of medical records and access control, cyber laws related to telemedicine.	

4.	<b>Mobile Based Tele-ECG:</b> Need for mobile based TM, Tele-ECG development, Tele ECG scenario on the globe, extension of mobile based approach for other vitalsignals, cloud based tele-monitoring, personal monitoring, Impact of mobile based Tele-ECG.	<b>06</b>
5.	<b>Mobile Telemedicine:</b> Components of tele-radiology system: Image acquisition system display system, tele pathology, multimedia databases, color images of sufficient resolution, dynamic range, spatial resolution, compression methods, interactive control of color, medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system – doctors, paramedics, facilities available. pharmaceutical information system.	<b>07</b>
6.	<b>Telemedicine Applications:</b> Telemedicine access to health care services – health education and self-care. introduction to robotics surgery, tele-surgery. tele- cardiology, telemedicine in neurosciences, electronic documentation, e-health services security and interoperability., telemedicine access to health care services, health education and self-care, business aspects – project planning, usage of telemedicine.	<b>07</b>

#### Text Books:

1. Norris, A.C. "Essentials of Telemedicine and Telecare", Wiley (ISBN 0-471-53151-0), First edition, 2002.
2. O'Carroll, P.W, Yasnoff W.A., Ward E.Ripp, L.H., Martin, E.L., "Public Health Informatics and Information Systems", Springer (ISBN 0-387-95474-0), 1st Edition, 2003.
3. Ferrer-Roca, O., Sosa-Iudicissa, M, "Handbook of Telemedicine", IOS Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90-5199-413-3), 3rd Edition, 2002.

#### Reference Books:

1. Simpson, W. "Video over IP- A practical guide to technology and applications", Focal Press(Elsevier). ISBN-10: 0-240-80557-7, 2006.
2. Wootton R. Craig, J., Patterson V. "Introduction to Telemedicine", Royal Society of Medicine Press Ltd (ISBN 1853156779), 2nd Edition, 2006.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML601	Biomedical Instrumentation – II Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML601	Biomedical Instrumentation – II Laboratory	25		25	50

Course Code	Course Name	Credits
<b>BML601</b>	<b>Biomedical Instrumentation – II Laboratory</b>	<b>01</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>To understand the basic principles and working of patient monitoring system.</li> <li>To develop skills enabling Biomedical Engineers to serve the health care industry</li> <li>To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.</li> </ul>	
<b>Course Outcome</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Design and Implement filters for filtering of noise from signals.</li> <li>Design and Implement Instrumentation amplifier to amplify low amplitude signals.</li> <li>Design and Implement a regulated power supply.</li> <li>Design and Implement Pulse Width Modulator.</li> <li>Understand the working of ECG machine by recording ECG.</li> <li>Provide a better understanding about foetal monitoring systems.</li> <li>Test the hearing ability using an audiometer.</li> </ul>	

**Syllabus: Same as that of (BMC601) Biomedical Instrumentation-II (BMI-II)**

**List of Laboratory Experiments: (Any Seven)**

1. Design of instrumentation amplifier
2. Implementation of notch filter
3. Implementation of bandpass filter
4. Design and implementation of regulated power supply
5. Demonstration of ECG machine / monitor
6. Demonstration of foetal monitor
7. Demonstration of blood flow measurement
8. Testing of hearing ability using audiometer
9. Industry / hospital visit may be conducted

Any other experiment based on syllabus which will help learner to understand topic/concept.

Group Presentations on the latest technology in hospitals based on the topics covered in the syllabus.



### **In Semester Assessment (ISA):**

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

### **Books Recommended:**

*Text books:*

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements: Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

*Reference books:*

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites

**Practical and Oral examination will be based on suggested practical list and entire syllabus.**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML602	Biomedical Digital Image Processing Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML602	Biomedical Digital Image ProcessingLaboratory	25		25	50

Course Code	Course Name	Credits
<b>BML602</b>	<b>Biomedical Digital Image Processing Laboratory</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>To be able to think about applying different Image processing techniques on agiven image.</li> <li>To know the fundamental concepts of a digital image processing techniques</li> <li>To be able to analyze problem and design algorithms to solve the problems.</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to...</b></p> <ul style="list-style-type: none"> <li>Acquire the fundamental concepts of a digital image processing system such asimage acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description.</li> <li>Analyze images in the spatial domain.</li> <li>Analyze images in the frequency domain through the Fourier transform.</li> <li>Apply the concepts of morphology, representation and description on images.</li> <li>Design and implement with MATLAB/C/Python algorithms for digital imageprocessing.</li> </ul>	

**Syllabus: Same as that of BMC602 Biomedical Digital Image Processing (Abbreviated as BDIP).**

**List of Experiments (using Matlab / C / Labview / python / other platform)**

1. Point processing techniques (At least 4 experiments)
2. Spatial domain filtering
3. Histogram processing (Histogram stretching, equalisation and matching)
4. Frequency domain filtering (Plotting 2D-DFT, low pass and high pass (Ideal, Butterworth andGaussian) filters
5. Segmentation - gradient operators
6. Compression - JPEG
7. Morphology - dilation erosion

**Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.**

**In Semester Assessment (ISA):**

ISA shall consist of minimum 8 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

**Text books:**

1. Digital Image Processing, Gonzalez and Woods - Pearson Education.
2. Fundamentals of Digital Image Processing, A.K. Jain – P.H.I.
3. Digital Image Processing and Analysis, Chanda Majumder - Printice Hall India.

**Reference Books:**

1. Digital Image Processing for Medical Applications, Geoff Dougherty, Cambridge University Press, 2009..
2. Digital Image Processing, William Pratt - John Wiley.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML603	Data Analysis in Healthcare Laboratory	--	2	--	1	1

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML603	Data Analysis in Healthcare Laboratory	25		25	50

Course Code	Course Name	Credits
<b>BML603</b>	<b>Data Analysis in Healthcare Laboratory</b>	<b>01</b>
<b>Course Objective</b>	To conduct analysis of medical data using Statistical tools.	
<b>Course Outcome</b>	Learner will be able to <ul style="list-style-type: none"> <li>• Plan the experiment for the given study</li> <li>• Form a sample of proper size</li> <li>• Use descriptive statistics to present the data</li> <li>• Apply statistical methods to analyse the data</li> <li>• Make inferences based on statistical theories</li> </ul>	

**Syllabus: Same as that of BML603 Data Analysis in Healthcare (DAH)**

Laboratory experiments may be conducted using Excel/ Python / R Studio /Tableau or any other Statistical tool/ software

#### List of experiments

1. Descriptive statistics and probability
2. Discrete probability distributions
3. Continuous probability distributions
4. Sampling distributions
5. Estimation
6. Hypothesis testing
7. Analysis of variance
8. Regression and Correlation
9. Chi square distribution and analysis of frequency
10. Anova
11. Kruskal-Wallis Test
12. Mann Whitney U-test

Any other experiment based on syllabus which will help students to understand topic/concept

#### In Semester Assessment (ISA):

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

### **Books Recommended:**

#### *Text books:*

1. Biostatistics – A foundation for analysis in health sciences by Wayne W. Daniel, Seventh edition, Wiley India
2. Fundamentals of mathematical statistics by S. C. Gupta and V. K. Kapoor, second edition, Sultan Chand Publisher
3. Probability and statistics for engineers by J. Ravichandran, Wiley India

#### *Reference Books:*

1. Biostatistics – How it works by Steve Selvin, Pearson education
2. An Introduction to Biostatistics by Sunder Rao and J. Richard, Third Edition, Prentice Hall of India
3. Probability and Statistics by Schaum's series

### **NPTEL/Swayam Course:**

#### *Course:*

Data Analysis and Decision Making - I by Prof. Raghunandan Sengupta, IIT Kanpur

<https://nptel.ac.in/courses/110/104/110104094/>

Descriptive Statistics with R Software By Prof. Shalabh, Prof. Prashant Jha IIT Kanpur, NIT Sikkim

[https://onlinecourses.nptel.ac.in/noc21\\_ma37/preview](https://onlinecourses.nptel.ac.in/noc21_ma37/preview)

**Oral examination will be based on suggested practical list and entire syllabus.**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BML604	Patient- care Automation Laboratory	--	4	--	2	2

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BML604	Patient-careAutomationLaboratory	25			25

Course Code	Course Name	Credits
<b>BML604</b>	<b>Patient-care Automation Laboratory</b>	<b>01</b>
<b>Course Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the fundamentals of automation and various components of automated instrumentation systems used in patient care such as sensors, data acquisition, data processing and visualization.</li> <li>• To understand the working of these systems and should be able to determine hardware and software requirements for the automated systems.</li> <li>• To understand how to design any application based on these systems.</li> <li>• To understand the requirements of patient safety and design safety instrumented systems</li> </ul>	
<b>Course Outcomes</b>	<p><b>Learner will be able to ...</b></p> <ul style="list-style-type: none"> <li>• Demonstrate the use of analog circuits in automation of biomedical instruments.</li> <li>• Demonstrate the use of digital circuits in automation of biomedical instruments.</li> <li>• Demonstrate and explain the working of automated patient care devices and instrumentation by proper selection and designing criteria, developing user friendly interfaces/GUI to make stand-alone biomedical instruments.</li> <li>• Explain the need of patient safety and use of safety features and devices in designing of the systems.</li> </ul>	

### List of Experiments (any 7)

1. Conditional decision making and switching of output devices like relays/ motors
2. Usage of indicating components (displays/ LED/ alarms) in biomedical applications
3. Use of peristaltic pump for dispensing the doses
4. Design of heart rate measurement circuits using analog components
5. Design of low-cost body temperature measurement unit
6. Automation of rehabilitation devices using electronic/ mechanical components
7. Design syringe pump driving circuit
8. User friendly user interfaces for biomedical equipment
9. Patient feedback designs using patient switch (audiometer)
10. Patient safety using safety switch (traction machine)
11. Design and approaches for nerve and muscle stimulator using wave form generators

## 12. Design of bio-signal transmission using modulation techniques

Note: The above experiments can be performed using the freeware or available simulation software

No single solution to any design and it depends on the available analog or digital resources.

### **In Semester Assessment (ISA):**

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

### **Books Recommended:**

*Text books:*

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and Measurements: Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHIPub)

*Reference books:*

1. Introduction to Biomedical Equipment Technology: Carr – Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol. I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMM601	Mini Project – 2 B	--	4\$	--	2	2
<b>Total</b>		<b>15</b>	<b>15</b>	<b>15</b>	<b>07</b>	<b>23</b>

CourseCode	Course Name	Examination Scheme			
		ISA	MSE	ESE	Total
BMM601	Mini Project – 2 B	25		25	50

Course Code	Course Name	Credits
<b>BMM601</b>	<b>Mini Project – 2 B</b>	<b>02</b>
<b>Course Objective</b>	<ul style="list-style-type: none"> <li>• To acquaint with the process of identifying the needs and converting it into the problem.</li> <li>• To familiarize the process of solving the problem in a group.</li> <li>• To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.</li> <li>• To inculcate the process of self-learning and research.</li> </ul>	
<b>Course Outcome</b>	Learner will be able to: <ul style="list-style-type: none"> <li>• Identify problems based on societal /research needs.</li> <li>• Apply Knowledge and skill to solve societal problems in a group.</li> <li>• Develop interpersonal skills to work as member of a group or leader.</li> <li>• Draw the proper inferences from available results through theoretical/ experimental/simulations.</li> <li>• Analyse the impact of solutions in societal and environmental context for sustainable development.</li> <li>• Use standard norms of engineering practices</li> <li>• Excel in written and oral communication.</li> <li>• Demonstrate capabilities of self-learning in a group, which leads to life long learning.</li> <li>• Demonstrate project management principles during project work.</li> </ul>	



## Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

## Guidelines for Assessment of Mini Project:

### In Semester Assessment (ISA)

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;

○ Marks awarded by guide/supervisor based on log book	10
○ Marks awarded by review committee	10
○ Quality of Project report	05

**Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.**

## **One-year project:**

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  - First shall be for finalisation of problem
  - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

## **Half-year project:**

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

## **Assessment criteria of Mini Project.**

**Mini Project** shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader

## 13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

### **Guidelines for Assessment of Mini Project Practical/Oral Examination:**

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

**Mini Project** shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication