UNIVERSITY OF MUMBAI

Revised Syllabus for the

M.E. (Bio-Medical Engineering)

(As per Choice Based Credit and Grading System with effect from the academic year 2016-2017)

From Co-ordinator's Desk:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and also to achieve recognition of the institution or program meeting certain specified standards. The main focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for post-graduate program in Bio-Medical Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for post-graduate program in Instrumentation Engineering are listed below;

Program Educational Objectives (PEOs)

- ➢ To create the competent & skilled engineers to ensure them the careers and employment and in this way fulfill the requirement of Multinational industries.
- ➢ To develop the strong ability in data analysis & their report towards an application for design and development of product & systems.
- ➢ Expose them by giving an opportunity as an individual as well as team.
- ➢ Facilitate strong base of basic scientific & engineering knowledge with professional ethics, lifelong learning attitude society globally.
- ➢ Be successful innovative and entrepreneur in the Bio-Medical field via consultancy work.

Program Outcomes (POs)

- ➢ Able to demonstrate & competent enough in basic knowledge in Mathematics, Engineering and Technology to obtain the solution of engineering problem.
- ➢ Have ability to formulate the engineering problem, design the setup for experimentation, analysis and interpretation of the result data, report preparation.
- ➢ Develop the competency to design an instrument system, engineering software's, simulated model and solutions etc as per desired specification & requirement as applicable/useful to public/society.
- ➢ Demonstrate the ability to work on basic engineering discipline as well as multi-disciplinary engineering teams to achieve the solution of engineering problem.
- ➢ Strong competency in using modern engineering tools like MATLAB / Simulink, LABVIEW/MultiSim for solution of Bio-Medical Engineering problems.
- ➢ Able to use the acquired knowledge and professional skill and project as well as

budget management towards betterment of the society.

➢ Understand the needs of the society worldwide in the context of his professional knowledge to ensure environmental safety and better sustainability.

➢ Capable to apply ethical principles with committed professional ethics and duties towards the solution of complex engineering problems.

➢ Motivate to work independently as well as a member of team or team leader in multi functionaries and diversified knowledge platforms.

➢ Develop an effective inter personnel communication skill at large with public and professional bodies. They will be able to comprehend the data and accordingly will prepare technical design details, datasheets, reports, documentation etc.

➢ Inculcate the lifelong learning in the purview of updates /upgrade in engineering and technology.

➢ Investigate the complex engineering problems using acquired knowledge in Bio-Medical engineering to develop industrial level solutions in the interest of society.

Dr. S. R. Deore
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

Program Structure for
M.E. Bio-Medical Engineering
University of Mumbai
(With Effect from 2016-17)

Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC101	Anatomy and Physiology For Engineers	04	-	-	04	-	-	04
BMC102	Bio-Medical Sensors, Applications and Intelligent Instrumentation	04	-	-	04	-	-	04
BMC103	Advanced Digital Signal Processing	04	-	-	04	-	-	04
BMDLO101X	Department Level Optional Course-I	04	-	-	04	-	-	04
ILO101X	Institute Level Optional Course-I	03	-	-	03	-	-	03
BML101	Laboratory-I	-	02	-	-	01	-	01
BML102	Laboratory-II	-	02	-	-	01	-	01
Total		**19**	**04**	**-**	**19**	**02**	**-**	**21**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem.	Exam. Duration			
		Test1	Test 2	Avg.					
BMC101	Anatomy and Physiology For Engineers	20	20	20	80	03	-	-	100
BMC102	Bio-Medical Sensors, Applications and Intelligent Instrumentation	20	20	20	80	03	-	-	100
BMC103	Advanced Digital Signal Processing	20	20	20	80	03	-	-	100
BMDLO101X	Department Level Optional Course-I	20	20	20	80	03	-	-	100
ILO101X	Institute Level Optional Course-I	20	20	20	80	03	-	-	100
BML101	Laboratory-I	-	-	-	-	-	25	25	50
BML102	Laboratory-II	-	-	-	-	-	25	25	50
Total		**100**	**100**	**100**	**400**	**-**	**50**	**50**	**600**

Program Structure for
M.E. Bio-Medical Engineering
University of Mumbai
(With Effect from 2016-17)

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC201	Biomedical Instrumentation and Design	04	-	-	04	-	-	04
BMC202	Biomedical Image Processing	04	-	-	04	-	-	04
BMC203	Advanced Medical Imaging	04	-	-	04	-	-	04
BMDLO202X	Department Level Optional Course-II	04	-	-	04	-	-	04
ILO202X	Institute Level Optional Course-II	03	-	-	03	-	-	03
BML201	Laboratory -III	-	02	-	-	01	-	01
BML202	Laboratory –IV	-	02	-	-	01	-	01
Total		**19**	**04**	**-**	**19**	**02**	**-**	**21**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem.	Exam. Duration			
		Test1	Test 2	Avg.					
BMC201	Biomedical Instrumentation and Design	20	20	20	80	03	-	-	100
BMC202	Biomedical Image Processing	20	20	20	80	03	-	-	100
BMC203	Advanced Medical Imaging	20	20	20	80	03	-	-	100
BMDLO202X	Department Level Optional Course-II	20	20	20	80	03	-	-	100
ILO202X	Institute Level Optional Course-II	20	20	20	80	03	-	-	100
BML201	Laboratory-III	-	-	-	-	-	25	25	50
BML202	Laboratory-IV	-	-	-	-	-	25	25	50
Total		**100**	**100**	**100**	**400**	**-**	**50**	**50**	**600**

Program Structure for
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Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theor	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMS301	Special Topic Seminar	-	06	-	-	03	-	03
BMD301	Dissertation–I	-	24	-	-	12	-	12
Total		**-**	30	-	-	15	-	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test1	Test 2	Avg.				
BMS301	Special Topic Seminar	-	-	-	-	50	50	100
BMD301	Dissertation–I	-	-	-	-	100	-	100
Total		**-**	**-**	**-**	**-**	**150**	**50**	**200**

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theor	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMD401	Dissertation–II	-	30	-	-	15	-	15
Total		**-**	30	-	-	15	-	15

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test1	Test 2	Avg.				
BMD401	Dissertation–II	-	-	-	-	100	100	200
Total		**-**	**-**	**-**	**-**	**100**	**100**	**200**

Note:
- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher
- **End Semester Examination:** In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Subject Code	Department Level Optional Course-I	Subject Code	Department Level Optional Course-II
BMDLO1011	Embedded Systems in Biomedical Engineering	BMDLO2021	Biorheology
BMDLO1012	Biomaterials and Implants	BMDLO2022	Robotics in Biomedical Engineering
BMDLO1013	Telemedicine	BMDLO2023	Neural Networks
BMDLO1014	Rehabilitation Engineering	BMDLO2024	Computer Networking in Medicine
BMDLO1015	Biomedical Informatics	BMDLO2025	Lasers and Fiber Optics for Therapy and Surgery
BMDLO1016	Healthcare Data Base Management System	BMDLO2026	Hospital Management and Information System

Subject Code	Institute Level Optional Course-I	Subject Code	Institute Level Optional Course-II
ILO1011	Product Lifecycle Management	ILO2021	Project Management
ILO1012	Reliability Engineering	ILO2022	Finance Management
ILO1013	Management Information System	ILO2023	Entrepreneurship Development and Management
ILO1014	Design of Experiments	ILO2024	Human Resource Management
ILO1015	Operation Research	ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO1016	Cyber Security and Laws	ILO2026	Research Methodology
ILO1017	Disaster Management and Mitigation Measures	ILO2027	IPR and Patenting
ILO1018	Energy Audit and Management	ILO2028	Digital Business Management
		ILO2029	Environmental Management

Subject Code	Subject Name	Credits
BMC101	**ANATOMY AND PHYSIOLOGY FOR ENGINEERS**	**04**

Course Objectives:

- To understand the human anatomy and functions of various body structures. To understand different physiological processes taking place inside human body.

Course Outcomes:

- Students will be well versed with the anatomy and physiology of human body. By this they will be able to correlate the knowledge of medicine and engineering for development of various instruments.

Module	Detailed Contents	Hours
1.	**Introduction to human body:** levels of structural complexity, Internal environment and homeostasis, overview of various systems, Introduction to special senses.	06
2.	**Study of cellular system and blood components:** Structure & functions of cell, Cellular transport (active and passive), diffusion, osmotic pressure, Body fluid compartments, origin of cell membrane potential - Nernst and Goldman equations – Action potential - Blood composition - functions of blood – functions of RBC, WBC, platelets, Physical & Physiological properties of blood.	08
3	**Cardiovascular system:** Anatomy of heart, Anatomy of vessels, Cardiac output, Heart sounds, Dynamics of heart, Systemic and pulmonary circulation, Blood pressure & its regulation **ECG-** Intra-cardiac ECG, Normal ECG, method for recording ECG, leads, Cardiac arrhythmias.	10
4	**Respiratory system:** Anatomy of lungs, parts of respiratory system, Organization of Ventilation, diffusion, gas exchange, Measurement of lung volumes & capacities, Lung compliance, surfactant Oxygen & carbon dioxide transport, composition of alveolar air, Control of respiration.	08
5	**Musculoskeletal system and Central nervous system:** Anatomy of brain, spinal cord, Organization & functions Receptors, synapses, reflexes, ANS, PNS, Ascending & descending tracts, Skeleton – anatomy, Structure & functions of Nerve& muscle , Mechanism of muscle contraction, Neuro – muscular transmission and processing of information.	08
6	**Endocrine system:** Secretion and Function of Pituitary gland, hypothalamus, thyroid gland, parathyroid glands, adrenal glands, pineal gland or body, tymus gland, various hormonal disorders.	08

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. Anatomy and Physiology in Health and Illness: Ross and Wilson. (ELBS Pub)
2. Textbook of Biomedical Physiology – A. C. Gayton

Reference Books:
1. Applied Physiology - C.A. Keeleand Eric Neil Samson, Wrights
2. The Physiological Basis of Medicine Practice - .Herbert Best Charles and Norman Tailo

Subject Code	Subject Name	Credits
BMC102	**BIOMEDICAL SENSORS, APPLICATIONS AND INTELLIGENT INSTRUMENTATION**	**04**

Course Objectives:
- To study the basic characteristics of measurement system.
- To study the different types of transducers: Displacement and Pressure transducers.
- To study the techniques used for measurement of Blood flow.
- To study Fiber Optic, Chemical and Radiation sensors.
- To study the biochemical measurements.

Course Outcomes:
- A learner will be able to get the clear domain knowledge about various measurement systems.
- Develop measurement systems by selecting different types of sensors.
- Do biochemical measurements

Module	Detailed content	Hours
1	**Introduction:** Transducers, Classification of Transducers, Principle of operation and their applications, Characteristics and choice of Transducers, Input, Output and Transfer Characteristics, Types of Errors.	04
2	**Displacement and Pressure Transducer:** Resistive: Bonded and unbonded strain gauge, Thermistor Inductive: self inductive and mutual inductive transducer, Rotary Variable Differential Transformer (RVDT), Linear Variable Differential Transformer(LVDT) Capacitive: Parallel plate transducer, Types(Change in area of plates, change in distance between plates, variation of dielectric constant) Self generating Transducers: Thermocouple, Integrated circuit Temperature Transducers, LM 335, LM 34, AD 592, Piezoelectric transducers Hall Effect Transducers: Magnetoelastic and Magnetostrictive transducers.	12
3	**Flow sensors:** Electromagnetic flow meter, Ultrasonic Blood flow meter, Indicator dilution methods, Fick Technique to measure cardiac output, Dye Dilution, Thermodilution, Laser Doppler Blood flow meter, Thermal convection velocity sensors, Spirometer using methods of Pressure Transducer and ultrasonic.	08
4	**Fiber Optic Sensors:** Blood Pressure sensor system, Extravascular sensors, Intravascular Fiber Optic sensors, Disposable Pressure sensors, Dynamic properties of Pressure Measurement Systems, Analogus Electric Systems, Measurement of system response, Effects of system parameters on response.	08
5	**Chemical Biosensors:** Blood Gas and Acid- Base Physiology, Electrochemical Sensors, Measurement of pH, P_{co2}, The P_{O2} Electrode, Chemical Fibrosensors, Intravascular measurements of oxygen saturation, Reversible Dye Optical measurement of pH, Fluorescence Optical pH sensor(Irreversible), Fluorescence optical P_{co2}, P_{O2} sensor, Design of an Intravascular Blood Gas monitoring system, ION-Sensitive Field Effect Transistor(ISFET), Immunologically Sensitive Field Effect Transistor(IMFET), Non-Invasive Blood Gas Monitoring, Pulse Oximetry, Blood Glucose Sensors, Electroenzymatic Approach, Optical Approach.	12

6	**Radiation Sensors:** Thermal Sensors and Quantum Sensors, Photoemissive Sensors, Photoconductive cells, Photomultiplier tube, Photojunction Sensors, Photovoltaic Sensors, spectral response, Photodiodes, Phototransistor, Photothyristor.	04

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. Electrical Measurements and measuring Instruments by A. K. Sawhney
2. Biomedical Transducers and Instruments by Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg
3. John G. Webster- Medical Instrumentation Applications and Design 3rd edition John Wiley and Sons. Inc. 1999

Reference Books:
1. Principle of Biomedical Engineering – Sunder Rajan V. Madihally
2. Sensors, Nano science and Biomedical Engineering and Instruments – Richard C. Dorf.
3. "Handbook of biosensors and electronic noses," Medicine, food and environment edited by Evikakress Rogers CRC press New York
4. "Biomedical instruments Theory and design," second edition, Waltezwelkowitzsiddentsch MeltinAkay
5. "Applied biosensors", Donald L Wise Butterworth Toronto

Subject Code	Subject Name	Credits
BMC103	**ADVANCED DIGITAL SIGNAL PROCESSING**	**04**

Course Objectives:
- To understand the students the concepts of frequency domain representation of heio signals, design and use of digital filers, adaptive filters, wavelets, corss correlation and auto correlaion to bio signals. To make students familiar with techniques of digital signal processing

Course Outcomes:
- Through this course students will understand the applications of digital signal processing to the bio-signals. Students can analyses the bio-signals using discrete Fourier transform. Students can design digital filters and use them for bio-signals for noise suppression and many other purposes. Students will be familiar with the concepts of wavelets, adaptive filtering and cross correlation. Students can apply these techniques for processing of bio-signals for extracting information for the signals.

Module	Detailed Content	Hours
1	**Introduction:** Types of Signals, Sampling, Sampling Theorem, Discrete Time & Continuous Time Signal Analysis, Analysis of Non-Stationary Signals, Overview of application of Signal Processing in Biomedical.	6
2	**Digital Filters:** Filter Specifications, Design of IIR filters: Design by Impulse Invariance method, Impulse Invariance method with Butterworth filter, Bilinear transformation, Bilinear transformation of Butterworth filter, Frequency Transformation.	8
3	**Frequency Domain Processing:** Fourier Transform of Periodic Signals, Discrete Fourier Transform, DFT of rectangular Pulse, Properties of DFT, DFT analysis of sinusoidal signals, Properties of Windows, Fourier analysis of non-stationary signals, Estimating the Power spectrum of Quantization noise.	8
4	**Adaptive Cancellation and Statistical Processing:** Adaptive filtering, Application of Adaptive filters, Mean Square Error, RLS and LMS Algorithm, Adaptive Lattice Ladder Filter, Adaptive Noise Control.	8
5	**Wavelet:** Introduction to wavelet, Scaling function and wavelet function, HAAR Wavelet, Daubechies Wavelet, Wavelet Filter Bank and it's complete reconstruction, Comparison of Wavelet with STFT, Application of Wavelet for Biomedical Signal Processing.	8
6	**Autoand Cross Correlation Techniques:** Correlation and Auto Correlation Sequences, Properties of Correlation and Auto Correlation Sequences, Correlation of Periodic Sequences, Input Output Correlation Sequence, Correlation Functions and Spectra at the output of LTI Systems, Auto Correlation, Auto Regressive Process, Moving Average Process, Computation of Correlation, Cross Correlation, Autocorrelation of Periodic signals and their properties, Biomedical Applications of Auto and Cross Correlation, Software Application of Echo Detection.	10

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. Electrical Measurements and measuring Instruments by A. K. Sawhney
2. Biomedical Transducers and Instruments by Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg
3. John G. Webster- Medical Instrumentation Applications and Design 3rd edition John Wiley and Sons. Inc. 1999

Reference Books:
1. Principle of Biomedical Engineering – Sunder Rajan V. Madihally
2. Sensors, Nanos cience and Biomedical Engineering and Instruments – Richard C. Dorf.
3. "Handbook of biosensors and electronic noses," Medicine, food and environment edited by Evikakress Rogers CRC press New York
4. "Biomedical instruments Theory and design,"second edition, Waltezwelkowitzsiddentsch Meltin Akay
5. "Applied biosensors", Donald L Wise Butterworth Toronto

Subject Code	Subject Name	Credits
BMDLO1011	**EMBEDDED SYSTEMS IN BIOMEDICAL ENGINEERING**	**04**

Course Objective:
- Understand the fundamentals of embedded systems, the basics of C and OOP concepts, understand the PIC microcontroller architecture (PIC), C language program for PIC microcontroller, Digital instrumentation and concepts of RTOS

Course Outcome:
- A Learner will be able to Write C language program for PIC microcontroller and Design PIC microcontroller based digital instrument

Module	Detailed content	Hours
1	**Embedded system introduction**: Introduction to embedded system, embedded system architecture, classifications of embedded systems, challenges and design issues in embedded systems, fundamentals of embedded processor and microcontrollers, CISC vs. RISC, fundamentals of Vonneuman/Harvard architectures, types of microcontrollers and selection of microcontrollers.	10
2	**Concepts of C & C++ programming:** C concepts and programming: Data types, Operators, Conditional statements & loops. Functions: Parameter passing-Pass by Value, Pass by Reference; creating modular programs using functions, Recursive functions. Structures & Unions: declaration, accessing members of structure, difference between structure and union, User Defined Data Types, Enumerated data type. Pointers: pointer basics and concepts, arrays and pointer relation, passing pointers to functions, dynamic memory allocation. Differences between C and C++, Fundamentals of object oriented programming. Basics of C++: features of C++, data types, standard I/O, arrays and strings in C++.	10
3	**PIC Architecture & C Programming:** Introduction to PIC microcontrollers, PIC architecture, instruction set, addressing modes & PIC, C programming examples.LCD and Keypad interfacing.	10
4	**Digital Instrumentation:** Summation-delta ADC's, Examples, ADS1298 for ECG, AFE 4300 for BCA (body composition analysis), AFE 4490 for oxygen saturation.	08
5	**Program modeling concepts & Real time operating system:** Modeling process for software analysis before implementation, Models for event control programs and multiprocessor system. Concepts of RTOS, I/O subsystems, network operating systems, real time and embedded operating systems.	10

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. The 8051 microcontrollers-Kenneth J Ayala
2. Rajkamal, Embedded systems-architecture, programming and design, Tata McGraw Hill.
3. Sriram Iyer & Pankaj Gupta, Embedded Real time systems programming, Tata McGraw Hill

Reference Books:
1. Embedded Microcomputer Systems- Real time Interfacing -Valvano Frank Vahid, Toney Givargis-Embedded System Design: A unified Hardware/Software Introduction John Wiley publication
2. David E. Simon -An Embedded Software Primer Pearson Education
3. Muhammad A Mazidi, The PIC Microcontroller and Embedded Systems, Pearson Education

Subject Code	Subject Name	Credits
BMDLO1012	**BIOMATERIALS AND IMPLANTS**	**04**

Course Objectives:
- To understand what biomaterials are, what are they made of, types of materials used for making bioimplants and in which all conditions of the body they are used. Also it emphasizes on various techniques to understand how the properties of these materials are studied.

Course Outcomes:
- A leaner can design an implant as per the need and also come to know a bioimplant is not compatable, what all complications it can lead to. Also understand how a biomaterial improves the quality of life and enhances the aesthetic looks of an individual too.

Module	Detailed content	Hours
1	**Introduction:** Introduction of biomaterials. Classification of biomaterials	02
2	**Physiological Defense Mechanisms of the body against biomaterials:** Inflammation and wound healing, Blood clotting system, Immune system, Complement system.	06
3	**Properties and applications of biomaterials:** Tantalum, Platinum and other noble metals.	05
4	**Biopolymers:** Collagen, Elastin, Mucopolysaccharides, proteoglycans, cellulose and other derivatives, chitin, other polysaccharides.	05
5	**Cardiovascular Implants and Extracorporeal Devices:**Vascular implants, cardiac pacemakers, blood substitutes, extracorporeal blood circulation devices	05
6	**Biomaterials in Opthalmology:** Contact Lenses, optical implants, drainage tubes in glaucoma, vitreous implants, acrylate adhesives, artificial tears	05
7	**Dental Materials:** Tooth composition and mechanical properties, Impression materials, bases, liners and varnishes for cavities, fillings and restorative materials, materials for deep cavities, oral implants, use of collagen in dentistry	05
8	**Techniques for characterization of surface properties of biomaterials:** Electron Spectroscopy for Chemical Analysis(ESCA), Secondary Ion Mass Spectrometry (SIMS), Surface Infrared Techniques, Transmission Electron Microscope(TEM), Scanning Electron Microscope(SEM), Scanning Tunneling Microscope(STM), Atomic Force Microscope (AFM), Surface Enhanced Raman Spectroscopy (SERS), High Resolution Electron Energy Loss Spectroscopy (HREELS)	10
9	**Thermal, Mechanical and Biological Testing of Biomaterials.**	05

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. An Introduction to Materials in Medicine by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons
2. Biomaterails by Sujata V. Bhat
3. Polymers: Biomaterials and Medical Applications, Encyclopedia Reprint Series, Editor: Jacqueline I. Kroschwitz.

Reference Books:
1. Biomaterials an Introduction by J. B. Park

Subject Code	Subject Name	Credits
BMDLO1013	**TELEMEDICINE**	**04**

Course Objectives:
- It emphasizes on various types of signals which are transmitted from one region to another by various communications and networking techniques, how data is exchanged and the safety and security of data is achieved.

Course Outcomes:
- Telemedicine plays a wide role in Biomedical engineering and the leaner can understand how this technique can be utilized in physiological data transfer, particularly Cardiac signals in ambulatory conditions.

Module	Detailed content	Hours
1	**Introduction:** History of telemedicine, Block diagram of telemedicine system, Definition of Benefits and limitations of telemedicine.	04
2	**Type of information**: Audio, Video, Still images, Text and data, fax, Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information- Doctors, paramedics, facilities available. Pharmaceutical information **Type of communications and network**, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave. Different Modulation techniques. **Types of antennas** depending on requirements, Integration and operational issues: - system integration, store –and - forward operation, Real-time Telemedicine.	10
3	**Data Exchange:** Network Configuration, circuit and packet switching, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN). Video Conferencing	08
4	**Data Security and Standards:** Encryption, Cryptography, Mechanisms of encryption, phases of Ecryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7.	08
5	**Ethical and legal aspects of Telemedicine:** Confidentiality, and the law, patient rights and consent, access to medical Records, Consent treatment, jurisdictional Issues, Intellectual property rights	08
6	**Applications of Telemedicine:**	10

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. Olga (EDT) Ferrer – Roca, M. Sosa (EDT) Iudicissa Hand book of Telemedicine IOS press

Reference Books:

1. A.C. Norris, Essentials of Telemedicine and Telecare John Sons & Ltd, 2002
   Reference http://jntu.ac.in/dap/syl.html

Subject Code	Subject Name	Credits
BMDLO1014	**REHABILITATION ENGINEERING**	**04**

Course Objectives:
- Identify the role of Rehabilitation Engineering in clinical practice.
- To study the need of Orthotics, Prosthesis and how it helps in quality life in an individual
- To study various design considerations of Artificial devices that supports the human sensory organs

Course Outcomes:
- A learner will able to understand the basic differences between Orthotics and Prosthesis. Design supporting devices as per the need of the patient. Understand and instruct various safety measures while using powered devices. Understand to what extend robotic devices are useful in manufacturing artificial devices

Module	Detailed content	Hours
1	**Introduction:** Introduction to Rehabilitation Engineering. Qualitative and quantitative description of the action of muscle in relation to the human movement, Gait cycle and Analysis , Various types of joint movements, Prehension Patterns, Sliding Filament Theory, Forward and Inverse dynamics of multi joint muscle driven system. Introduction to blood rheology, flow in circulatory system.	10
2	**Prosthetics, Orthotics and Rehabilitation Robotics:** Prosthetics: Introduction, upper, lower and external, internal prosthetics- Orthotics: Functional electrical stimulation (FES), ambulatory aids, aids for daily living, prosthetics using myo-electric signal control- Rehabilitation robotics: Introduction, configuration and its components, control and sensor.	10
3	**Mobility aids:** Types of Mobility Aids, Manual and Powered Wheel Chairs, Design and selection of components, Wheel chair safety.	06
4	**Basics of Mechanics:** Stress strain curve, constitutive equation and field equation encountered in fluids, Viscoelasticity. Models of material behavior, measurement and characteristics of muscle, bone tendons, ligaments and skin.	08
5	**Sensorial Prosthesis and Artificial Organs:** Sensory rehabilitation Engineering, Retinal rehabilitation, Rehabilitation of Brain and Spinal cord	08
6	**Kinesiology:** Kinesiolgy and muscle function application of mechanics to describe the material properties of living tissues, Levers, Freebody diagram	06

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Rehabilitation Medicine – Dr. S. Sunder Jaypee Medical publications New Delhi

Reference Books:

1. Physical rehabilitation – Susan D. O'Sullivan, Thomas J Smitz. 5th edition
2. Rory. A. Cooper- Rehabilitation Engineering Applied to Mobility and Manipulation, First Edition, CRC Press, 2010

Subject Code	Subject Name	Credits
BMDLO1015	**BIOMEDICAL INFORMATICS**	**04**

Course Objectives:
- To understand various concepts like medical records, data acquisition and computing. It also helps in understanding how patient care monitors are helpful in acquiring data and Understanding the importance and the generation of certain algorithms

Course Outcomes:
- This helps in the Analysis and Interpretation of various biological data with the help of Medical records, mathematical analysis and Computing. It is widely used in Tele Health sector too.

Module	Detailed content	Hours
1	**Introduction:** Origins of Biomedical Informatics, Relationship of biomedical informatics to other fields, Biomedical Data acquisition, storage and use of Computer based medical records	06
2	Patient care systems and Patient Monitoring Systems	08
3	**Data Mining:** Introduction to data mining, basic aspects of data measurement, types of variables, Visualization and data exploration, Clustering algorithm.	08
4	**Fitting Models:** Basic principles of fitting models to data, Classification Algorithms, Regression Algorithms	06
5	**Information Retrieval:** Basic principles of Information Retrieval and Search, document classification algorithms, document clustering algorithms	08
6	**Information Management:** Management of Information in Healthcare Organizations, Public Health Informatics, Health Information Infrastructure, consumer health informatics, Telehealth and mhealth and future of Biomedical Informatics.	12

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Public Health Informatics and Information Systems by D.A. Ross, A.R. Hinman, K. Saarlas, and W.H. Foege (Hardcover – Oct 16, 2002)

Reference Books:

1. Androwich, I.A., Bickford, C.J., Button, P.S., Hunter, K.M., Murphy, J., and Sensmeier, J. (2002) Clinical Information Systems: A Framework for Reaching the Vision. Washington, DC: ANA Publishing

Subject Code	Subject Name	Credits
BMDLO1016	**HEALTHCARE DATA BASE MANAGEMENT SYSTEM**	**04**

Course Objectives:

- It deals with computerized management of patient data, importance of computers in clinical laboratory, and how computers help in assisting doctors to take medical decisions, also the role of computers in conducting/performing therapy.

Course Outcomes:

- With the Application of Computers in many fields, particularly in the hospitals, various Medical decisions have become much faster and patient's life safety is also much more improved. Also at any given point of time, all possible medical data is also available in hospital due to computerization.

Module	Detailed content	Hours
1	**Introduction to Data Base Management Systems:** Database system applications, database system versus file system, view of data, data models, database language, Database users and administrators, Transaction management, database system structures, Application Architectures	08
2	**Hospital Information System:** Introduction, Functional capabilities of a computerized HIS, Need for computerization in hospitals, Security of computer records, Cost effectiveness of information processing by computer, Sources of data for decision making, Modes of decision output to physician, Regenstrief computerized medical record system, Computer DBMS in obstetrics- gynecology, Computer based morbidity registers	08
3	**Computerized Patient Data Base Management:** Introduction, History-taking by computer, Dialogue with the computer, Methods of history taking by computers, Patient data base management by computers. Computerized medical record –Evolution.	06
4	**Computers in Clinical Laboratory:** Introduction, Data base approach to Laboratory Computerization, Automated Clinical Laboratories, Automated Methods in Hematology, Chromosome Analysis by computer, Computerized Electrocardiography (ECG), Assessment of performance of ECG computer programs, Computerized Electroencephalography, Computerized Electromyography.	10
5	**Computer Assisted Medical Decision-Making:** Introduction, General Model of CMD, Algorithmic Methods, Statistical pattern classification, Decision Analysis, Fuzzy set theory, Production Rule Systems, Cognitive Models, Internist, QMR, KES, A rule based decision aid for TIA. Computers in the care of Critically Ill Patients: Automated computer Assisted Fluid and Metabolic balance, Pulmonary Function Evaluation, Cardiovascular Physiologic Evaluation.	08
6	**Computer Assisted Therapy:** Introduction, Digitalis Therapy, Evaluation of Patient response, Assessing Digitalis Toxicity, Computers for care of renal disorders, Computer based cancer Chemotherapy protocol advisor- ONCOCIN, Automated Drug	08

delivery, Electromyogenic Controlled Limbs. Computer Aids for the Handicapped: Introduction, Mobility, Blind and Visually Handicapped, Computer aids for the deaf, computer speech generation and recognition.	

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Text Books:
1. Data Base Management Systems (3rd) Raghu Ramakrishnan, JohanisGehrkMcGrawhill

Reference Books:
1. Computers in Medicine – Dr. R. D. Lele Tata Mcgraw Hill Medical Informatics a Primer - Mohan Bansal TMH publications

Subject Code	Subject Name	Credits
ILO1011	**PRODUCT LIFE CYCLE MANAGEMENT**	**03**

Objectives:
- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…
- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	12
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	06
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in	06

	Product Design, Examples/Case studies	
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	06
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	06

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1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Subject Code	Subject Name	Credits
ILO1012	**RELIABILITY ENGINEERING**	**03**

Objectives:
- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complex systems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…
- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	10
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	10
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	10
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

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4. Only Four question need to be solved.

REFERENCES:
1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Subject Code	Subject Name	Credits
ILO1013	**MANAGEMENT INFORMATION SYSTEM**	**03**

Objectives:

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development
- Define and analyze various MIS management responsibilities, including planning, budgeting, project management, and personnel management
- Discuss critical ethical and social issues in information systems

Outcomes: Learner will be able to…

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	**Introduction To Information Systems (IS):** Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	7
02	**Data and Knowledge Management:** Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	9
03	**Ethical issues and Privacy:** Information Security. Threat to IS, and Security Controls	6
04	**Social Computing (SC):** Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	**Computer Networks** Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	**Information System within Organization:** Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	10

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REFERENCES:

1. Management Information Systems: Kelly Rainer, Brad Prince by Wiley
2. Management Information Systems: Managing the Digital Firm (10th Edition). K.C. Laudon and J.P. Laudon, Prentice Hall, 2007.
3. Managing Information Systems: Strategy and Organization, D. Boddy, A. Boonstra, Prentice Hall, 2008

Subject Code	Subject Name	Credits
ILO1014	**DESIGN OF EXPERIMENTS**	**03**

Objectives:
- To understand the issues and principles of Design of Experiments (DOE).
- To list the guidelines for designing experiments.
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…
- Plan data collection, to turn data into information and to make decisions that lead to appropriate action.
- Apply the methods taught to real life situations.
- Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	08
03	**Two-Level Factorial Designs:** The 2^2 Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs.	07
04	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	07
05	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	07
06	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	04

<u>Assessment</u>:

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paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

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4. Only Four question need to be solved.

REFERENCES:
1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Philip J Ross, "Taguchi Technique for Quality Engineering," McGraw Hill.
7. Madhav S Phadake, "Quality Engineering using Robust Design," Prentice Hall.

Subject Code	Subject Name	Credits
ILO1015	**OPERATIONS RESEARCH**	**03**

Objectives:
- Formulate a real-world problem as a mathematical programming model.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…
- Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand.
- Understand the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems.
- Solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of, basic methods for, and challenges in integer programming
- Model a dynamic system as a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, Historical Background, Scope of Operations Research , Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools , Structure of the Mathematical Model, Limitations of Operations Research	02
02	**Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, *Simplex Method* Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, *Duality*, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	06
03	**Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	06
04	**Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	06

05	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	06
06	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation *Monte-Carlo Method:* Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	04
07	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	04
08	**Games Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	04
09	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	04

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4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.

4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Subject Code	Subject Name	Credits
ILO1016	**CYBER SECURITY AND LAWS**	**03**

Objectives:
- To understand and identify different types cyber crime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Outcomes: Learner will be able to…
- Understand the concept of cyber crime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafé and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	10
03	**Tools and Methods Used in Cyberline:** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace :** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.:** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000,IT Act. 2008 and its Amendments	8
06	**Information Security Standard compliances :** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

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4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008-TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Subject Code	Subject Name	Credits
ILO1017	**Disaster Management and Mitigation Measures**	**03**

Objectives:
- To understand the various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To know warning systems, their implementation and based on this to initiate training to a laymen
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…
- Understand natural as well as manmade disaster and their extent and possible effects on the economy.
- Planning of national importance structures based upon the previous history.
- Understand government policies, acts and various organizational structure associated with an emergency.
- Know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction:** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters**: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion . Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	06
03	**Disaster Management, Policy and Administration:** Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	**Institutional Framework for Disaster Management in India:** Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set	06

	up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
05	**Financing Relief Measures**: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures**: Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by RajdeepDasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications

7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Subject Code	Subject Name	Credits
ILO1018	**ENERGY AUDIT AND MANAGEMENT**	**03**

Objectives:
- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…
- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:**	10

	Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press

7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Subject Code	Laboratory Name	Credits
BML101	Laboratory I	01

Module	Practical based on
1	Blocking Oscillator using IC555
2	Study of LVDT
3	Design and implementation of analog filters(LP, HP, BP) for Bio-signal conditioning
4	Design and implementation of Medical Thermometer
5	Programmable Waveform Generator (XR-2240)
6	Study of Various Characteristics of sensors
7	Interfacing MSP430 Launch Pad and Arduino
8	Design and implementation of Biopotential Amplifier

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Laboratory Name	Credits
BML102	Laboratory II	01

Module	Practical based on
1	Design and simulation of IIR filters
2	Design and simulation of FIR filters
3	Suppression of respiratory artifacts in ECG using wavelet decomposition
4	Detection of ECG R peaks
5	Suppression of respiratory artifacts in ECG using adaptive filtering
6	Simulation of Frequency domain representation of biosignals
7	Measurement cardiac tiem intervals using simultaneously recorded ECG and PPG
8	Simulation of autocorrelation and cross correlation for biosignals

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Subject Name	Credits
BMC201	**BIOMEDICAL INSTRUMENTATION AND DESIGN**	**04**

Course objectives:

- To make students to understand various types of medical instruments, their working principles, and applications. To teach the students design concepts of some of the medical equipments. To make students to know instruments used in ICU, ICCU units. Instruments used for diagnosis of various disorders in body. To understand concepts of telemedicine

Course outcome:

- Students can design elecrodiagnostic instruments, understand use of medical equipment in various departments in the hospital and instrument's used for diagnostic, therapeutic, diagnosis, monitoring purposes

Module	Detailed Contents	Hours
1	**Introduction:** Classification on the basis of applications and their working principles, techniques of blood pressure measurement, measurement of heart rate, measurement techniques for body temperature, respiration rate meter, apnea detector.	8
2	**Electro diagnostic techniques**: Specifications and design of ECG, EMG, EEG, PPG amplifiers and filters.	8
3	**Intensive and coronary care units**: Special care units, ICU/CCU equipments, bedside monitors circuits, central montoring consoles, physiological telemetry	8
4	**Emergency equipments**: Introduction and design concepts of cardiac pacemaker and defibrillator, types and application techniques, analysis of pacemaker and defibrillator waveform, Respiratory and pulmonary function monitoring equipments, clinical lab equipments	8
5	**Therapeutic and general equipments**: Ultrasound therapy, short wave therapy, nerve and muscle stimulator, infant imcubator, hemodialysis machine, heart lung machine, cobalt therapy	8
6	**Analysis and processing of biosignals**, suppression of artifacts in biosignals, extarctijng features of in biosignals, telemedicine	8

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus

should be covered in question papers of end semester examination.

Text Books

1. John G. Webster- Medical Instrumentation Applications and Design 3rd edition John Wiley and Sons. Inc. 1999
2. Joseph J Carr, Joseph M. Brown- Introduction to Biomedical equipment technology, Pearson Education. Inc. 4h ediion, 2008

Subject Code	Subject Name	Credits
BMC202	**BIOMEDICAL IMAGE PROCESSING**	**04**

Course Objective:
- To understand the basics of bio-medical image processing systems.
- To study the concept of medical images obtained with ionizing and non-ionizing radiation.
- To develop computer aided diagnosis in analyzing and quantifying biomedical data.

Course Outcome:
- A learner will be able to Apply image processing concepts for medical images.
- Analyze Morphology, Segmentation techniques and implement them in images.
- Do quantitative analysis and visualization of medical images of numerous modalities such as
- PET, MRI, PACS, CT, or Ultrasound.

Module	Detailed content	Hours
1	**Introduction to Imaging systems:** Objects and images, The digital image processing system, Applications of digital image processing.	04
2	**Imaging systems:** The human visual pathway, Photographic film, Other sensors, Digitizing an image, The quality of a digital image, Color images, Computer-based activities.	06
3	**Medical images obtained with ionizing radiation:** Medical imaging modalities, Images from x-rays, Images from γ-rays, Dose and risk. Medical images obtained with non-ionizing radiation: Ultrasound imaging, Magnetic resonance imaging, Picture archiving and communication systems (PACS).	06
4	Fundamentals of digital image processing, The gray-level histogram, Histogram transformations and look-up tables. Image enhancement in the spatial domain: Algebraic operations, Logical (Boolean) operations , Geometric operations, Convolution-based operations, Image enhancement in the frequency domain : The Fourier domain, The Fourier transform , Properties of the Fourier transform, Sampling, Cross-correlation and autocorrelation, Imaging systems – point spread function and optical transfer function, Frequency domain filters, Tomographic reconstruction.	12
5	**Image restoration:** Image degradation, Noise, Noise-reduction filters, Blurring, Modeling image degradation, Geometric degradations, Morphological image processing: Mathematical morphology, Morphological operators, Extension to grayscale images. Image segmentation: Introduction to segmentation, Thresholding, Region-based methods, Boundary-based methods.	06
6	**Feature recognition and classification:** Object recognition and classification, Connected components labeling, Features, Object recognition and classification, Statistical classification, Structural/syntactic classification, Applications in medical image analysis. Three-dimensional: visualization: Image visualization , Surface rendering, Volume rendering, Virtual reality.	07

7	**Medical applications of Imaging:** Computer-aided diagnosis in mammography, Tumor imaging and treatment, Angiography, Bone strength and osteoporosis, Tortuosity.	07

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination

Text Book:
1. Digital Image Processing for Medical Applications, GEOFF DOUGHERTY, Cambridge University Press.

Reference Books:
1. Medical Image Processing, Reconstruction and Restoration, Jiri Jan, Taylor & Francis

Subject Code	Subject Name	Credits
BMC203	**ADVANCE MEDICAL IMAGING**	**04**

Course Objective:
- Identify the role of Imaging in clinical practice.
- To study the operating principles, processes of image acquisition, image reconstruction and quality Control aspects of various imaging modalities.
- To study risks associated with imaging technology.
- Identify advantages and Limitations of various Imaging modalities.
- To keep the students abreast with the technological developments in the field of Medical Imaging.

Course Outcome: A learner will able to:
- Describe essential physics, principle and physiology fundamental of Medical Imaging systems.
- Compute image reconstructions of different imaging modalities using reconstruction methods.
- Apprehend the importance of radiation constructive utilization and safety.
- Identify basic causes of image contrast and artefacts.
- Describe the clinical applications of each Imaging modality.
- Apply their knowledge to understanding emerging Medical Imaging technologies.

Module	Detail Contents	Hours
1	**Introduction to Medical Imaging Techniques:** Basic physics and working principle of X-ray, Computed Tomography, Ultrasonography, Magnetic Resonance Imaging and Nuclear Imaging.	5
2	**X-Ray Imaging:** X-ray m/c controls, Interaction of Radiation with Matter, Filters, Collimators and Grids. Circuit design of X-ray Generator and Timing the X-ray Exposurein Radiography. Power Ratings and HeatLoading, X-ray Exposure Rating Charts, Charged-Coupled Devices (CCDs), Flat Panel Detectors, Digital Radiography, ComputedRadiography, Digital Mammography,Fluoroscopy and DSA, Patient Dose Considerations. Clinical Applications.	10
3	**Computed Tomography(CT):** CT generations, Detectors , Detector Arrays , Details of Acquisition, Radon Transform, Tomographic Reconstruction techniques: Back Projection, Convolution and Back Projection, Iterative methods, Fourier Method, Contrast and CT Angiography, Radiation Dose and Safety, Image Quality, Artifacts, Clinical Applications, Principle of 3D imaging.	8
4	**Magnetic Resonance Imaging (MRI):** Relaxation parameters and their measurements. Magnets, RF coils and Gradients in MRI. Slice selection, Phase encoding, Frequency encoding, Pulse Sequences: Spin Echo, Inversion Recovery and Gradient Recalled Echo. k-space Data Acquisition and Image Reconstruction, Functional MRI, MRI Angiography, Artifacts, Clinical Applications, Biological effects and Safety.	10
5	**Ultrasound Imaging:** Interaction of ultrasound with biological matter,	7

	Ultrasound beam patterns and focusing. Ultrasound transducer and probes, A Mode, B Mode and M Mode, Instrumentation for ultrasound imaging system, Doppler ultrasound, Ultrasound Contrast Imaging, Clinical Applications, Principle of 3D ultrasound, Bio effects.	
6	**Nuclear Imaging:** Physical Half-life and Decay equation, Nuclear decay processes, Radiation Interactions with matter, Production of Radionuclides used in Imaging, Pulse Height Analyser, Rectilinear Scanner, Gamma Camera, Instrumentation of SPECT and PET, Reconstruction techniques, PET/CT, Therapy Equipment's: Cobalt 60 and LINAC, clinical applications, Biological effects and Radiation Safety.	8

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or Seminar on Advance Technology related to modules.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. "The Essential Physics of Medical Imaging" by Jerrold T Bushberg, J.Anthony Seibert, Edwin M Leidholdt,John M Boone, Lippincott.
2. "Physics of Medical Imaging", Taylor and Francis Group.
3. "Christensen's Physics of Diagnostic Radiology" by Thomas S. Curry , James E. Dowdey , Robert E. Murry.
4. "The Physics of Diagnostic Imaging" by David Dowsett, Patrick A Kenny, R Eugene Johnston

Reference Books:
1. Manuals of various imaging modalities.

Subject Code	Subject Name	Credits
BMDLO2021	**BIORHEOLOGY**	**04**

Course Objective:
- To understand various characteristics of tissue such as elasticity, Viscocity, Plasticity and also types of viscocity and Stress strain characteristics of tissue.
- Also how tissues can be modeled will be understood.

Course Outcome:
- From the terms elasticity, plasticity and viscosity, and using Stress Strain Curve,tissue modeling can be achieved.

Module	Detailed content	Hours
1	**Introduction:** Introduction to rheology and recap of basic equations of continuum mechanics (kinematics of deformation and stress analysis).	06
2	**Constitutive equations:** General theory of constitutive equations.	06
3	**a. Tissue and cell elasticity:** Continuum approach (linear theory, nonlinear theory, strain energy function, prestress; examples) **b. Tissue and cell elasticity:** Microstructural approach (microstructural models of living tissues), statistical approach (thermodynamics of elastic deformation, rubber elasticity), examples.	10
4	**Tissue and cell viscoelasticity:** Phenomenological approach (stress relaxation, creep, hysteresis, frequency and temperature effects), examples.	08
5	**Linear viscoelasticity:** Continuum approach, lumped models, empirical models (power law, fractional calculus), structural damping, examples. Microstructural and molecular approach, polymer chain dynamics, examples.	08
6	**Elements of nonlinear viscoelasticity:** Examples of empirical, semi empiroical and molecular approaches in studies of living tissues	06
7	**Elements of tissue plasticity and viscoplasticity:** (permanent deformation, hysteresis, yield stress), empirical and lumped models of plastic and viscopalstic behavior of living tissues.	04

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions

to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. Fung, Y. C. Biomechanics – Mechanical Properties of Living Tissues, 2nd edition, Springer: New York, 1993.
2. Fung, Y. C. Biomechanics – Motion, Flow and Growth, Springer: New York, 1990.
3. Fung, Y. C. Biodynamics – Circulation, Springer, 1984.
4. Fung, Y. C., N. Perrone, and M. Anliker (editors). Biomechanics – Its Foundations and Objectives, Prentice-Hall: Englewood Cliffs, NJ, 1972.
5. Mow, V. C., F. Guilak, R. Tran-Son-Tay, and R. Hochmuth (editors). Cell Mechanics and Cellular Engineering, Springer: New York, 1994.
6. Mofrad, M. R. K., and R. D. Kamm (editors). Cytoskeletal Mechanics: Models and Measurements. Cambridge University Press: New York 2006

Reference Books:

1. M. R. King (editor). Principles of Cellular Engineering: Understanding the Biomolecular Interface. Elsevier Academic Press, 2006.
2. Abé, H., K. Hayashi, and M. Sato (editors). Data Book on Mechanical Properties of Living Cells, Tissues, and Organs, Springer: Tokyo, 1996.
3. Silver, H. F. Biological Materials: Structure, Mechanical Properties, and Modeling of Soft Tissues, New York University Press: New York, 1987.10. Ward, I. M. Mechanical Properties of Solid Polymers, 2ndedition, Wiley: Chicester, 1983
4. Turner, A., Jr. Mechanical Behavior of High Polymers, Interscience: New York, 1984.
5. Erich, F. R. (editor). Rheology – Theory and Applications, Vol. 1 -Academic Press, 1956

Subject Code	Subject Name	Credits
BMDLO2022	**ROBOTICS IN BIOMEDICAL ENGINEERING**	**04**

Course Objective:
- To Understand Control of actuators in Robotic Mechanisms, robotic sensors and Kinematics of Robotic Arms

Course Outcome:
- It helps the learner to design a Robot for various applications like Surgery, therapy and clinical applications.

Module	Detailed content	Hours
1	**Introduction to robotics and its Applications in Biomedical Engineering:** Classification, Specification, Robot programming, Surgical application, Rehabilitation application, Clinical application.	06
2	**Control of actuators in Robotic Mechanisms:** Closed loop control in a position servo, Control of robotic joint, Stepper Motors, Brushless DC motors, Direct drive actuator, Hydraulic actuators, Pneumatic systems, Servo amplifiers.	08
3	**Robotic Sensory Devices:** Non-optical position sensors, Optical position sensors, Robot calibration using an optical incremental encoder, Instability resulting from using an incremental encoder, Velocity sensors, Accelerometers, Proximity sensors, Touch and slip sensors, Force and torque sensors.	08
4	**Robot Arm kinematics:** Direct kinematics problem, Inverse kinematics solution. **Robot Arm Dynamics** Lagrange's equation, Kinetic and Potential energy, Generalised force, Lagrange-Euler dynamic model, Dynamic model for Two-Axis Planar articulated Robot & three axis SCARA robot, Direct and Inverse dynamics, Recursive Newton-Euler formulation, Dynamic model of One-axis Robot(Inverted endulum).	12
5	**Workspace analysis and trajectory planning Robot Vision:** Digitization of image, Image segmentation, Edge detection, Shape analysis, Iterative Processing, Algorithms for image processing, Structured Illumination, Derivation of depth measurement using laser (Ranging by triangulation), Problems based on template matching, Shape analysis, region labelling, run length encoding, Perspective & inverse perspective transformations.	08
6	**Fuzzy logic control :** Fuzzy control: what is needed, Crisp values vs. Fuzzy Values, Fuzzy Sets: Degree of Membership and Truth, Fuzzification, Fuzzy Inference Rule Base, Defuzzification, Application of Fuzzy logic in Robotics.	06

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. Richard D. Klafter, Thomas A. Chmiclewski and Michael Negin, "Robotic Engineering: an integrated approach," Prentice-Hall India,India, 2003.
2. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, "Robotics: Control, Sensing, Vision, and Intelligence," McGraw Hill, Singapore, 1987.

Reference Books:
1. Robert J. Schilling, "Fundamentals of Robotics: Analysis and Control," Prentice-Hall India, India, 2005.
2. Saeed B. Niku, "Introduction to Robotics: Analysis, Systems, Applications," Pearson, India, 2003.
3. John J. Craig, "Introduction to Robotics: Mechanics and Control," Third Edition, Pearson, India, 2009.

Subject Code	Subject Name	Credits
BMDLO2023	**NEURAL NETWORKS**	**04**

Course Objective:
- To understand the basic concepts of artificial neural network (ANN),study the various ANN Models, study single layer and multilayer feed forward neural networks, familiarize about the support vector machine and adaptive resonance theory, study the basic concepts of Fuzzy sets and system, learn ANN in biomedical applications

Course Outcome:
- A Learner will be able to apply concepts of ANN in Biomedical applications, apply concepts of Fuzzy Sets in Biomedical applications

Module	Detailed content	Hours
1	**Introduction to Neural Networks:** Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.	06
2	**Essentials of Artificial Neural Networks:** Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN Connectivity, Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules	08
3	**Single Layer and Multi Layer Feed forward Neural Networks:** Introduction, Classification of Perceptron Models: Discrete, Continuous and Multi-Category, Training and classification using Discrete Perceptrons: Algorithm examples. Linearly separable classifications. Multicategory single layer perceptron networks. Lineraly nonseparable classification, Delta learning Rule, Feed forward recall and error back- propagation training. Learning factors. Kolmogorov Theorem, Learning Difficulties and Improvements.	10
4	**Special Networks:** Adaptive Resonance Theory (ART): Introduction, ART Fundamentals, ART 1, ART 2. Support Vector Machine (SVM): Introduction, Optimal Hyper plane for linearly separable and non separable patterns, SVM for Pattern recognition and Nonlinear Regression. Radial basis Function Network (RBFN): Architecture and training Algorithm.	08
5	**Classical & Fuzzy Sets and Fuzzy Logic System Components:** Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions, Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.	10
6	**Neural Networks applications in Biomedical:** Brain Maker to improve Hospital Treatment using Adaline, Breast cancer Detection using ART network, Access control by Face recognition using Back propagation Neural network.	06

Assessment:

Internal:	Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination:	Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:

1. S. Rajasekharan and G. A. Vijayalakshmipai, "Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications", PHI Publication, 2004.
2. John Yen and Reza Langan, "Fuzzy Logic: Intelligence, Control and Information", Pearson Education, 2004.

Reference Books:

1. Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2001.
2. S. N. Sivanandam, S. Sumathi,S. N. Deepa "Introduction to Neural Networks using MATLAB 6.0", TMH, 2006.
3. James A Freeman and Davis Skapura, Neural Networks Pearson Education, 2002.
4. Timothy J. Ross, " Fuzzy Logic With Engineering Applications", McGraw-Hill Inc. 1997.

Subject Code	Subject Name	Credits
BMDLO2024	**COMPUTER NETWORKING IN MEDICINE**	**04**

Course Objective:
- To understand various techniques for data communication and data transfer Enable the leaner to know about Application Layer Data Link Layer Network Layer Transport Layer

Course Outcome:
- It helps the leaner to know how computer networking takes place in medicine by Application Layer Data Link Layer Network Layer, Transport Layer

Module	Detailed content	Hours
1	**Data Communications:** Components, Direction of Data flow Networks - Components and Categories, types of Connections, Topologies, Protocols and Standards – OSI model, TCP/IP Protocol	06
2	**Data Transmission** Transmission Media– Coaxial Cable – Fiber Optics – Line Coding – Modems – RS232 Interfacing sequences Circuit Switching, Throughput, bandwidth, T1, ISDN, DSL	06
3	**Data Link Layer:** Types of errors, Error detection and correction Methods - Block Codes, Cyclic Codes, checksum Data link Control Protocols - stop and wait , go back-N ARQ , selective repeat ARQ, HDLC. Wired and wireless LAN/WAN, connecting LANs, backbone networks LAN	08
4	**Network Layer** Internetworks – Packet Switching and Datagram approach – IP addressing methods – Subnetting – Routing – Distance Vector Routing – Link State Routing – Routers.	08
5	**Transport Layer** Duties of transport layer, Multiplexing, Demultiplexing, Sockets, User Datagram Protocol (UDP), Transmission Control Protocol (TCP) - Congestion Control, Quality of services (QOS).	10
6	**Application Layer** Domain Name Space (DNS), SMTP, FTP, HTTP, WWW, SNMP	05
7	**Security Concepts** System security in general, Authentication, Authorization, Confidentiality, Integrity, Cryptography	05

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. Computer Network – Behrouz A. Forouzan, McGraw Hill.
   Reference Books:
1. Computer Networks – Andrew S. Tanenbaum

Subject Code	Subject Name	Credits
BMDLO2025	**LASERS AND FIBER OPTICS FOR THERAPY AND SURGERY**	**04**

Course Objective:
- To Understand the basic Physics of generation of lasers ,Types of Lasers ,its construction, general construction of Optic fiber, Modes and need of Laser and fiber optics in medicine.

Course Outcome:
- It enables the learner to understand the Types of laser and its Medical applications and various safety aspects and trouble shooting

Module	Detailed content	Hours
1	**Introduction :** Historical background. Medical Lasers: Introduction, Laser physics-fundamentals, principles, advances, Medical Lasers-fundamentals, principles, advances. Medical Laser Systems-fundamentals, principles. Laser safety-fundamentals. Laser interaction with tissue-principles; laser assisted diagnostics-principles, applications of lasers in diagnosis and imaging-advances, laser surgery and therapy-principles-photothermal & photomechanical mechanisms, thermal interaction between laser and tissue-advances.	10
2	**Single Optical Fibres:** Introduction, historical background, optical fibers-fundamentals, light transmission in optical fibers-principles, optical properties of optical fibers-advances, fabrication of optical fibers-principles, optical fibers for UV, visible, IR light-principles, power transmission through optical fibers-principles, modified fiber ends and tips-principles, fiber lasers-advances.	08
3	**Optical Fibre Bundles:** Introduction, non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiberoptic bundles for imaging devices-fundamentals & principles, fiberscopes and endoscopes-fundamentals, fiber optic imaging systems-advances.	10
4	**Applications of Lasers in Therapy and Diagnosis:** Introduction, laser assisted diagnosis and therapy-fundamentals, interaction of laser beams and materials-principles.	08
5	**Clinical Applications of Fiber Optic Laser System:** Introduction, fiberoptic laser systems in cardiovascular disease, gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, and flow diagram for laser angioplasty & photodynamic therapy. Endoscopy	12

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Text Books:
1. Lasers and Optical Fibers in Medicine – AbrahimCatzir Academic press 1998.

Reference Books:
1. Therapeutic Lasers – G David Baxter – Churchill Living stone publications
2. Medical Laser and their safe use – David H Shiny Stiffen and L Trokel Springer Publications
3. Element of Fiber optics – S. L. Wymer Regents PHI

Subject Code	Departmental Elective Course : Subject Name	Credits
BMDLO2026	Hospital Management and Information System	04

Course Objective:
- To understand various features like hospital management, planning and design of various divisions in a hospital. Also emphasise is given on patient safety and certain Legal aspects

Course Outcome:
- The leaner will be able to understand the complete designing of the hospital, its safety for patients, Also helps in understanding the supporting units in a hospital and hoe to deal various legal matters in a hospital

Module	Detailed content	Hours
1	**Introduction to Management:** Process of Management and Basic Management Principles, Role of Hospital Administrator.	05
2	**Computers in Medicine:** Computers in Biomedical Applications, Role of computers in data collection and analysis, computer aided decision making, computer based medical record.	05
3	**Planning and designing:** Planning and design considerations of various dept. like OT, OPD, CSSD, Nursing unit, ICUs, Pathology, Radiology, Pharmacy and others.	12
4	**Hospital Safety and Management:** Security and Safety of hospital property, staff and patients. Importance of Disaster management, medical codes.	04
5	**Patient safety:** Electrical beds, double insulation system, patient isolation, grounding, rectification of ground faults.	04
6	**Hospital Services:** Clinical services, Suppotive services, Auxillary services and Ancillary services.	14
7	**Legal Aspect:** Health Insurance, Quality assurance, Medico legal aspects, Medical Ethics.	04

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester

Text Books:
1.Electrical safety in Healthcare facility – H. H. Roth
2. Hospital Planning, Design and Management-Kunders

Reference Books:

1. Biomedical Ethics for Engineers- Domiel A Vallero
2. Computer in Medicine – R. D. Lele

Subject Code	Subject Name	Credits
ILO2021	**PROJECT MANAGEMENT**	**03**

Objectives:

- To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management	8

	techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting:** Project procurement management, contracting and outsourcing,	
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.

2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA

3. Gido Clements, Project Management, Cengage Learning.

4. Gopalan, Project Management, , Wiley India

5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Subject Code	Subject Name	Credits
ILO2022	**FINANCE MANAGEMENT**	**03**

Objectives:
- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
- Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…
- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.**Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market. **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05

06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Subject Code	Subject Name	Credits
ILO2023	**ENTERPRENEURSHIP DEVELOPMENT AND MANAGEMENT**	**03**

Objectives:
- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Outcomes: Learner will be able to…
- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life	05

	cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Subject Code	Subject Name	Credits
ILO2024	**HUMAN RESOURCE MANAGEMENT**	**03**

Objectives:
- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource Management (HRM) processes, related with the functions, and challenges in the emerging perspective.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of behavioral skills, Inter- personal, inter- group in an organizational setting.
- To prepare the students as future organizational change facilitators, stable leaders and managers, using the knowledge and techniques of human resource management.

Outcomes: Learner will be able to…
- Gain knowledge and understand the concepts about the different aspects of the human resource management.
- Understand and tackle the changes and challenges in today's diverse, dynamic organizational setting and culture.
- Utilize the behavioral skill sets learnt, in working with different people, teams & groups within the national and global environment.
- Apply the acquired techniques, knowledge and integrate it within the engineering/ non engineering working environment emerging as future engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR:** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB) :** Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues, Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness, Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	7
03	**Organizational Structure & Design :** Structure, size, technology, Environment	6

	of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
04	**Human resource Planning:** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR :** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment, Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. SubbaRao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Subject Code	Subject Name	Credits
ILO2025	**PROFESSIONAL ETHICS AND CORPORAT SOCIAL RESONSIBILITY (CSR)**	**03**

Objectives:
- To understand professional ethics in business
- To recognized corporate social responsibility

Outcomes: Learner will be able to…
- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	rporate Social Responsibility: Articulation of Gandhian Trusteeship rporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	rporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

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4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Subject Code	Subject Name	Credits
ILO2026	**RESEARCH METHODOLOGY**	**03**

Objectives:

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences , Objectives of Research, **Issues** and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	**10**
02	**Types of Research:** Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	**08**
03	**Research Design and Sample Design :** Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**08**
04	**Research Methodology :** Meaning of Research Methodology, Stages in Scientific Research Process **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem:** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research:** Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation	**04**

Assessment:

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4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Subject Code	Subject Name	Credits
ILO2027	**IPR AND PATENTING**	**03**

Objectives:
- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…
- understand Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	06
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCE BOOKS:
1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield,2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph&Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar andmohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. KompalBansal and PraishitBansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual

Property Rights,

12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005,Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Subject Code	Subject Name	Credits
ILO2028	**PRODUCT LIFE CYCLE MANAGEMENT**	**03**

Objectives:
- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Outcomes: The learner will be able to …..
- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business:** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce: E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system, **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business, Security Threats to e-business - Security Overview, Electronic Commerce Threats, Encryption, ryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	aterializing e-business: From Idea to Realization-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-en OECD Publishing

Subject Code	Subject Name	Credits
ILO2029	**ENVIRONMENTAL MANAGEMENT**	**03**

Objectives:
1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…
1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to**

number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Laboratory Name	Credits
BML201	Laboratory III	01

Module	Practicals based on
1	To Design and implementation of heart rate meter
2	To Design and implementation of brady-cardia and tachycardia detector
3	To Design and implementation of ECG pre amplifier
4	To Design and implementation of nerve muscle stimulator
5	To Design and implementation of asynchronous cardiac pacemaker
6	To Design and implementation of apnea detector
7	To Design and implementation of signal conditioning for PPG signal
8	To Design and implementation of implementation of analog filter for biosignals

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Laboratory Name	Credits
BML202	Laboratory IV	01

Module	Practicals based on
1	Filtering in Frequency domain
2	Filtering in Spatial Domain
3	Skeletonisation
4	Biomedical Image Compression Biomedical Image Compression
5	Reconstruction using Filter Back Projection
6	Reconstruction using algebraic technique
7	Feature Extraction
8	Statistical Processing (Histogramic, Rescaling)

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners.

Subject Code	Subject Name	Credits
BMS301	**Seminar**	**03**

Guidelines for Seminar:
- o Seminar should be based on thrust areas in Bio-medical Engineering.
- o Students should undergo literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the topic and compile the report in standard format and present in front of Panel of Examiners appointed by the Head of the Department/Institute of respective Program.
- o Seminar assessment should be based on following points:
  - • Quality of Literature survey and Novelty in the topic.
  - • Relevance to the specialization
  - • Understanding of the topic
  - • Quality of Written and Oral Presentation

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions/Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

Subject Code	Subject Name	Credits
BMD301/ BMD401	**Dissertation (I and II)**	**12 + 15**

Guidelines for Dissertation:
o Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt the solution to the problem by analytical/simulation / experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation-I:
o Dissertation-I should be assessed based on following points
  • Quality of Literature survey and Novelty in the problem
  • Clarity of Problem definition and Feasibility of problem solution
  • Relevance to the specialization
  • Clarity of objective and scope
o Dissertation-I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Program.

Guidelines for Assessment of Dissertation-II:
o Dissertation-II should be assessed based on following points
  • Quality of Literature survey and Novelty in the problem
  • Clarity of Problem definition and Feasibility of problem solution
  • Relevance to the specialization or current Research / Industrial trends
  • Clarity of objective and scope
  • Quality of work attempted
  • Validation of results
  • Quality of Written and Oral Presentation
o Dissertation-II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai.

Students should publish at least one paper based on the work in reputed International/ National Conference / Refereed Journal.