AC

Item No.

UNIVERSITY OF MUMBAI

Revised Syllabus for the

Biomedical Engineering

(Final Year – Semester VII and VIII)

(As per Choice Based Credit and Grading System
with effect from the academic year 2019–2020)

Scheme for Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC801	Biomedical Microsystems	04	----	----	04	----	----	04
BMC802	Hospital Management	04	----	----	04	----	----	04
BMDLO804X	Department Level Optional Course – IV	04	----	----	04	----	----	04
ILO202X	Institute Level Optional Course – II	03	----	----	03	----	----	03
BML801	Biomedical Microsystems	----	02	----	----	01	----	01
BML802	Hospital Management	----	02	----	----	01	----	01
BMDLL804X	Department Level Optional Course Laboratory – IV	----	02	----	----	01	----	01
BML803	Project Stage II	----	12	----	----	06	----	06
Total		**15**	**18**	----	**15**	**09**	----	**24**

Examination Scheme for Semester VIII

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC801	Biomedical Microsystems	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC802	Hospital Management	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 801X	Department Level Optional Course - IV	80	32	20	8	---	---	---	---	---	---	---	---	100
ILO202X	Institute Level Optional Course –II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML801	Biomedical Microsystems	---	---	---	---	25	10	---	---	25	10	---	---	50
BML802	Hospital Management	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 801X	Department Level Optional Course Laboratory – IV	---	----	---	---	25	10	---	---	25	10	---	---	25
BML803	Project Stage II	---	---	---	---	50	20	---	---	---	---	50	20	100
Total		**320**	**128**	**80**	**32**	**125**	**50**	**---**	**---**	**75**	**30**	**50**	**20**	**625**

Course Code	Department level Optional Course – III
BMDLO7031	Networking and Information in Medical System
BMDLO7032	Advanced Image Processing
BMDLO7033	Embedded Systems

Course Code	Department level Optional Course – IV
BMDLO8041	Health Care Informatics
BMDLO8042	Robotics in Medicine
BMDLO8043	Nuclear Medicine

Course Code	Institute level Optional Course – I
ILO1011	Product Lifecycle Management
ILO1012	Reliability Engineering
ILO1013	Management Information System
ILO1014	Design of Experiments
ILO1015	Operation Research
ILO1016	Cyber Security and Laws
ILO1017	Disaster Management and Mitigation Measures
ILO1018	Energy Audit and Management

Course Code	Institute level Optional Course - II
ILO2021	Project Management
ILO2022	Finance Management
ILO2023	Entrepreneurship Development and Management
ILO2024	Human Resource Management
ILO2025	Professional Ethics and Corporate Social Responsibility (CSR)
ILO2026	Research Methodology
ILO2027	IPR and Patenting
ILO2028	Digital Business Management
ILO2029	Environmental Management

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC801	Biomedical Microsystems (Abbreviated as BM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC801	Biomedical Micro-systems (BM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC801	Biomedical Microsystems	04
Course Objectives	• To understand various fabrication techniques for MEMS devices. • To apply the knowledge of MEMS in Biomedical field. • To understand recent advancements in Biomedical Engineering for a successful career in the area of nanotechnology.	
Course Outcomes	**Learner will be able to…** • Understand basic property and select appropriate material for MEMS application • Develop or modify the MEMS processes for a simple MEMS device in order to reduce the fabrication time. • Understand different microfabrication techniques and choose appropriate technique • Analyze Micro total analysis system with designing of its components • Demonstrate working principles of Bio Nano-sensors and drug delivery devices with types and fabrication • Understand packaging techniques used in MEMS	

Module	Contents	Hours
1	**Introduction to miniaturization and materials** • Block diagram of MEMS and BIOMEMS, comparison, examples • Clean room: definition, classification, air flow system • Safety in handling hazardous materials in clean room • Scaling Laws in Miniaturization • Substrates and Wafers: CZ process, wafer types • Materials: Properties and applications of single crystal silicon, SiO2, Si3N4, SiC, Polysilicon, GaAs, Glass, Al, Gold, PMMA, PDMS, SU8, Conducting polymers	**08**
2	**MEMS FABRICATION PROCESSES** • Wafer cleaning processes: RCA, Piranha • PVD: definition, Types: Evaporation (Thermal and E-beam) and Sputtering (DC and RF), applicable materials, advantages, disadvantages • CVD: definition, reaction steps, types: APCVD, LPCVD, PECVD, and HWCVD, applicable materials, advantages, disadvantages • Oxidation: Thermal • Polymers coating techniques: spinning, spraying and electrodeposition • Doping: definition, Types: Ion implantation and Diffusion, advantages, disadvantages • Etching: Types: Dry etching (RIE, DRIE) and wet etching (isotropic and anisotropic), advantages, disadvantages, specific etchants • Photolithography: Definition, steps, light sources (UV, DUV, and EUV), positive and negative photoresist, mask, different projection systems • X-ray lithography: Synchrotron radiation, X-ray mask • Nanolithography: EBL • Surface characterization techniques: AFM, SEM, TEM, Ellipsometer, Profilometer	**12**
3	**Microfabrication Techniques** • Bulk micromachining: definition, advantages and disadvantages Examples: pressure sensor, dissolved wafer process, CO_2 sensor • Surface micromachining: definition, advantages and disadvantages Examples: pressure sensor, cantilever Non polysilicon surface micromachining: SOI fabrication • LIGA: definition, process steps, examples, advantages and disadvantages, Molding techniques: Injection, compression, hot embossing • Soft lithography: Definition, SAMs, Types: Micro contact Printing, • Micro molding techniques: replica molding, microtransfer molding, micromolding in capillaries and solvent-assisted micromolding	**04**
4	**MICRO TOTAL ANALYSIS SYSTEMS (μTAS)** • Basic block diagram	**08**

	• Flow techniques in µ-fluidics: pressure driven force, electro-osmosis, electrophoresis • Micropump, microvalves: types and fabrication • Microchannels: Types and fabrication (SU8, glass, silicon) • Separation techniques: capillary electropherosis, electrochromatography, isoelectric focusing Detection techniques: fluorescence, chemiluminiscence	
5	**MICRO/ NANO BIOSENSORS AND DRUG DELIVERY DEVICES** • Biosensor: definition, block diagram • Classification based on the basis of detection techniques: Electric, Magnetic, Optical, Thermal, Mechanical, and Chemical • Basic steps involved in the development of biosensors: surface modification, immobilization, integration with transducer • Design, fabrication of cantilever for antibody detection • Hypodermic needles, transdermal patches : disadvantages • Micro needles: solid, hollow, polymer, silicon (fabrication) Nano particles for drug delivery	**10**
6	**MICROSYSTEM PACKAGING** • Packaging materials • Levels of packaging • Comparison between IC and MEMS packaging • Packaging technologies: Die preparation, surface bonding, wire bonding, sealing • Pressure sensor packaging	**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.

Books Recommended:

Text Books:

1. "MEMS & MICROSYSTEMS Design and Manufacture", Tai-Ran Hsu, TATA Mcgraw-HILL.
2. "Fundamentals of Microfabrication" Marc Madou, CRC Press.

Reference Books:

1. "Fundamentals of BioMEMS and Medical Microdevices", Steven S. Saliterman, (SPIE Press Monograph Vol. PM153 by Wiley Interscience
2. "Microsystem Technology", W. Menz, J. Mohr, 0. Paul, WILEY-VCH, ISBN 3-527-29634-4
3. "Electro Mechanical System Design", James J. Allen, Taylor & Francis Group, LLC, ISBN-0-8247-5824-2, 2005
4. "MICROSYSTEM DESIGN",Stephen D. Senturia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-306-47601-0

5. “Introduction to Microfabrication”, Sami FranssilaJohn Wiley & Sons Ltd, ISBN 0-470-85106-6
6. “Microelectromechanical Systems”, Nicolae Lobontiu, Ephrahim Garcia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-387-23037-8
7. “BIOMEDICAL NANOTECHNOLOGY”, Neelina H. MalschCRC PRESS, Taylor and Francis Group, ISBN 10: 0-8247-2579-4

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC802	Hospital Management (Abbreviated as HM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC802	Hospital Manage-ment (HM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC802	Hospital Management	04
Course Objectives	• To understand the basic principles used for designing of various departments in the hospital. • To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve Hospitals. • Apply modern engineering and management principles to provide high quality of hospital care tin the community.	
Course Outcomes	**Learner will be able to** • Understand and apply resource management concepts (personnel, finance, and material resources) and the processes and strategies needed in specific hospital sectors. • Understand the management structure and functions in hospital. Communicate effectively and develop their leadership and team building abilities. • Understand the principles of designing, implementing and commissioning of clinical services and supportive departments in the hospital. • Understand the roles and responsibilities of Biomedical Engineer in hospital. • Understand the functions of other Engineering services and axillary services • Understand and apply materials management concept in industry	

Module	Contents	Hours
1	**Process of management:** Principles of management, Leadership, Motivation, Time management, , H.R. management (Recruitment, Performance appraisal, Training and development,), effective communication, Accounting - Types of Budget	08
2	**Organization of the hospital & Hospital Planning:** Management structure, Types of hospitals, Governing body, Hospital committee and hospital functionaries, Duties and responsibilities of various positions. Guiding principles in planning hospital facilities and services and planning the hospital building	06
3	**Clinical and Supportive Services :** Clinical Services: **(Location, Layout , equipment** And personnel): Emergency, IN patient, OUT patient, Intensive care unit, Operation Theatre, Laboratory, Blood Bank, Radiology **Supportive services:** Registration Medical record department, Central Sterile Service Dept, Pharmacy, Laundry and Linen Medical social service Dept. Hospital security, Housekeeping, Dietary (Food services)	14
4	**Biomedical Engineering Department: (Location, Layout, equipment and personnel and functions)** Roles and responsibilities of Biomedical Engineer in hospitals, Maintenance types: Routine(preventive) and breakdown Maintenance contracts (CMC and AMC)	05
5	**Other Engineering and Auxiliary Services :** A) Engineering Services (Electrical, Mechanical and Civil) : Responsibilities and functions, Hospital Ventilation and Air Conditioning, Medical Gas systems, Communication, Hospital information systems B) Auxiliary Services: Waste management, Hospital Infection control, Disaster management	08
6	**Material Management & Inventory Control** Classification of Materials Purchase Management: Purchase system(Centralized, Decentralized, Local purchase), Purchase Procedures: Selection of Suppliers, Tendering procedures, Analyzing bids, Price negotiations, Issue of purchase orders, Rate Contracts. Store Management: Functions of Store Manager, Materials handling, Flow of goods/FIFO. Inventory Control**:** Lead-time, Buffer stock, Reorder level, Two Bin System, EOQ	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.

Books Recommended:

Text Books:

1. Hospital Management by Dr. Pradyna Pai
2. Hospital Planning, Designing and Management: Kunders G D, Gopinath, A katakam (Private Pub Bangalore)

Reference Books:

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE Pub Bangalore
3. Careers in Biomedical : Shantanu Thatte.

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 8041	Department Level Optional Course –IV: Healthcare Informatics (Abbreviated as HCI)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 8041	Healthcare Informatics (HCI)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO8041	Healthcare Informatics	04
Course Objectives	• To understand the healthcare interoperability semantic and syntactic. • To understand the standards of healthcare interoperability standards for Medical Images and Medical Messages	
Course Outcomes	**Learner will be able to** • Understand Healthcare interoperability standards • Fabricate HL7 Messages • Understand and Design UML Diagrams • Understand semantic interoperability through DICOM • Edit and Compare DICOM file	

Module	Contents	Hours
1.	**Healthcare Interoperability** Standards In Healthcare System, Categorizing Standards, Standard Development, Various Healthcare Informatics Standards, Need for a Lingua Franca, Electronic Health Records, Interoperability Modelling Basics	04

2.	**HL7 Version 2** Message Syntax, Delimiters, Segment Definition, Message Header MSH, Patient Identification Details (PID) , Patent Visit (PV1), Request and Specimen Details (OBR) , Result Details (OBX), Z-Segments, Data, Simple Data Types, Complex Data Types, Codes and Identifiers, Names and Addresses, Other Complex Data Types	**08**
3.	**Unified Modelling Language (UML):** Use Case Diagrams, Activity Diagrams, Class Diagrams, Sequence Diagrams **HL7 Version 3:** Main goal of V3, V3 Development Methodology, V3 Messaging Components, Artifacts of the V3 Design Methodology, Dynamic Models, Static Models Clinical Document Architecture: Data Types, Codes and Vocabularies, Header , Body	**12**
4.	**DICOM standard:** Introduction, DICOM Grammar: VRs, DICOM Data Dictionary, DICOM Objects, DICOM Information Hierarchy, Modules, IODs and IEs	**06.**
5.	**DICOM Communications:** DICOM SOPs, Unit Identification on n/w, Services and Data, DIMSE Example: C-Echo, Storage, Query: Find, C-Find IOD, C-Find DIMSE, C-Cancel, Modality Worklist, Basic DICOM Retrieval: C-Get, Advanced DICOM Retrieval: C-Move, DICOM: Ping, Push and Pull	**08.**
6.	**DICOM Associations** Association Establishment, Transfer Syntax, Application Context, **DICOM Media: Files, Folders, and DICOMDIRs** DICOM File Format, DICOM File Services, Storing DICOM Data in PACS	**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.

Books Recommended:

Text Books:

1. Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards), Springer Publication by Tim Benson
2. Digital Imaging and Communication in Medicine by Oleg S. Pianykh, Springer Publication
   CDA™ Book, By Keith Boone, Springer Publication

Reference Books:

1. Informatics in Medical Imaging, George C. Kagadis, Steve G. Langer CRC Press

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 8042	Department Level Optional Course –IV: Robotics in Medicine (Abbreviated as RIM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 8042	Robotics in Medicine (RIM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO8042	Robotics in Medicine	04
Course Objectives	• To introduce to basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning. • To introduce to various applications of Robots in Medicine.	
Course Outcomes	**A Learner will be able to** • Design basic Robotics system and formulate Kinematic, Inverse Kinematic motion planning solutions for various Robotic configurations. • Design Robotic systems for Medical application.	

Module	Contents	Hours
1.	Introduction Automation and Robots, Classification, Application, Specification, Notations	06
2.	Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation, (Five- axis robot, Four-axis robot, Six-axis robot)	08

3.	Inverse Kinematics General properties of solutions tool configuration Five axis robots, Three-Four axis, Six axis robot(Inverse Kinematics). Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.	**10**
4.	Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation (Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration).	**10**
5.	Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.	**08**
6.	Applications in Biomedical Engineering Application in rehabilitation, Clinical and Surgery	**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.

Books Recommended:
Text books:
1. Fundamentals of Robotics-Analysis and control, Robert Schilling, Prentice Hall of India.
2. Robotics, Fu,Gonzales and Lee, McGraw Hill
3. Introduction to Robotics, J.J,Craig,Pearson Education

Reference Books:
1. Robotics and AI, Staughard, Prentice Hall Of India.
2. Industrial Robotics - Grover, Wiess, Nagel, Oderey, , McGraw Hill.
3. Robotics and Mechatronics. Walfram Stdder,
4. Introduction to Robotics,Niku, Pearson Education.
5. Robot Engineering, Klafter, Chmielewski, Negin, Prentice Hall Of India.
6. Robotics and Control, Mittal, Nagrath, Tata McGraw Hill publications.

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 8043	Department Level Optional Course –IV: Nuclear Medicine (Abbreviated as NM)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 8043	Nuclear Medicine (NM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO8043	Nuclear Medicine	04
Course Objectives	• To enable the students to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment. • To keep the students abreast with the technological developments in the field of nuclear medicine.	
Course Outcomes	**Learners will be able to** • Understand essential physics of nuclear medicine such as basic concepts of radioactivity, its measurement, interaction with matter and radionuclide production. • Understand concepts of radiopharmaceuticals and various aspects of radiation safety. • Apply the principles of physics to understand working of various detectors and counting systems. • Study principle of operation of different scanning system and their quality control function. • Understand various Emission Tomography Techniques along with their Clinical Applications. • Understand concept of radionuclide therapy and the function of	

	radiotherapy equipment.

Module	Content	Hours
1.	**Basics of Nuclear Physics**: Radioactivity, Radioactive Decay Law, Radioactive Decay Processes, Decay scheme of Mo-99. Units of Radioactivity Measurement, Successive Decay Equations. Statistics of Counting, Interaction of Radiation with Matter **Production of Radionuclide:** Methods of radionuclide production: Nuclear Reactor, Medical Cyclotron & Radionuclide Generators Spectra of commonly used radio nuclides e.g Tc-99m, Cs-137. Problems in radiation measurements.	**10**
2.	**Radiopharmaceuticals:** Ideal Radiopharmaceutical, Methods of Radiolabeling **Internal Radiation Dosimetry:** Absorbed Dose Calculations to Target & Non-Target Tissues, MIRD Methodology **Radiation Safety:** Natural & Artificial Radiation Exposure, External & Internal Radiation Hazard, Methods of Minimizing External Exposure, Methods of Preventing Internal Exposure, Evaluation of External & Internal Hazard, Biological Effects of Radiation, Radioactive Waste Management.	**08**
3.	**Detectors in Nuclear Medicine & Counting and Measuring System:** Gas filled Detectors, Scintillation Detectors and Solid State Detectors, Scintillation Counting System, Gamma Ray Spectrometry, Radionuclide Dose Calibrator, Properties of Detectors. **In Vitro techniques(Brief Description):** Introduction, Single and Double Isotope method, Radioimmunoassay, RIA Counting System, Liquid scintillation Counting system, RIA Applications.	**10**
4.	**In Vivo Techniques:** General Principle, Uptake Monitoring System, Rectilinear Scanner, Gamma Camera Fundamentals, Position Circuitry and working, Computer Interface, Performance Parameters, Quality Control Functions	**07**
5.	**Emission Tomography Techniques and Clinical Applications**: Introduction, Principles and applications of SPECT, Principles and applications of PET, System performance parameters and Quality Control Functions. **Introduction to Hybrid Modalities:** PET/CT, SPECT/CT **Clinical Applications** Clinical Applications of PET, SPECT and Hybrid Modalities in Cardiology, Neurology and Oncology.	**08**
6.	**Radionuclide Therapy** Choice of a Radionuclide in Therapeutic Nuclear Medicine Treatment of Benign & Malignant Diseases Palliative & Curative Procedures Radiotherapy Equipment: Cobalt unit, Gamma knife	**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.

Books Recommended:
Text Books:

1. J. Harbert and A.F.G. Rocha, *Textbook of Nuclear medicine*, Second Edition, Lea& Febiger.
2. B.R. Bairi, Balvinder Singh, N.C. Rathod and P.V. Narurkar, *Handbook of Nuclear medicine Instruments*, Tata McGraw – Hill.
3. Gopal B. Saha, *Fundamentals of Nuclear Pharmacy*, Springer Science+Business Media
4. Ramesh Chandra, *Introductory Physics of Nuclear Medicine*, Lea& Febiger.

References Books:

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

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2021	Institute Level Optional Course –II: Project Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2021	Institute Level Optional Course – II Project Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2021	Project Management	03
Course 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.	
Course 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	Hours
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).	05
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.	06
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).	08
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	06
05	**Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** Project procurement management, contracting and outsourcing,	08
06	**Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration,	06

	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.	

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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2022	Institute Level Optional Course –II: Finance Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2022	Institute Level Optional Course – II Finance Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2022	Finance Management	03
Course 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	
Course Outcomes	**Learner will be able to** • Understand Indian finance system and corporate finance • Take investment, finance as well as dividend decisions	

Module	Detailed Contents	Hours
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity	06

	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	
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**

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. 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.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2023	Institute Level Optional Course –II: Entrepreneurship development and Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO2023	Institute Level Optional Course – II Entrepreneurship Development and Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2023	Enterpreneurship Development and Management	03
Course Objectives	• To acquaint with entrepreneurship and management of business • Understand Indian environment for entrepreneurship • Idea of EDP, MSME	
Course 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	Hours
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of	04

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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2024	Institute Level Optional Course –II: Human Resource Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2024	Institute Level Optional Course – II Human Resource Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2024	Human Resource Management	03
Course 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.	
Course 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	Hours
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.	**05**
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	**07**
03	**Organizational Structure & Design:** Structure, size, technology, Environment 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.	**06**
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	**05**

	Methods	
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.	**06**
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:

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. 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. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2025	Institute Level Optional Course –II: Professional Ethics and Corporate Social Responsibility	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2025	Institute Level Optional Course – II Professional ethics and Corporate Social Responsibility	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2025	Professional Ethics and Corporate Social Resonsibility (CSR)	03
Course Objectives	• To understand professional ethics in business • To recognized corporate social responsibility	
Course 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	Hours
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	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	**08**
06	**Corporate 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:

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. 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.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2026	Institute Level Optional Course –II: Research Methodology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
ILO2026	Institute Level Optional Course – II Research Methodology	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2026	Research Methodology	03
Course 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	
Course Outcomes	**Learner will be able to** • Prepare a preliminary research design for projects in their Course 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,	**04**

	Validity Testing & Ethical Issues, Suggestions and Recommendation	

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. 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, (2^{nd}ed), Singapore, Pearson Education

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2027	Institute Level Optional Course –II: IPR and Patenting	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO2027	Institute Level Optional Course – II IPR and Patenting	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2027	IPR and Patenting	03
Course 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	
Course 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	Hours
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:

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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.

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
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11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,

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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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2028	Institute Level Optional Course –II: Digital Business Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO2028	Institute Level Optional Course – II Digital Business Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2028	Digital Business Management	03
Course Objectives	• To familiarize with digital business concept • To acquaint with E-commerce • To give insights into E-business and its strategies	
Course 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	**M Materializing 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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ILO2029	Institute Level Optional Course –II: Environmental Management	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ILO2029	Institute Level Optional Course – II Environmental Management	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
ILO2029	Environmental Management	03
Course Objectives	• Understand and identify environmental issues relevant to India and global concerns • Learn concepts of ecology • Familiarise environment related legislations	
Course Outcomes	**Learner will be able to** • Understand the concept of environmental management • Understand ecosystem and interdependence, food chain etc. • Understand and interpret environment related legislations	

Module	Detailed Contents	Hours
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy	10

	scenario.	
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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML803	Project Stage - II	--	12	--	--	06	--	06

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML 803	Project Stage - II	--	--	--	--	50	--	--	100	150

Course Code	Course Name	Credits
BML803	Project Stage-II	06
Course objective	• Implement the concept of Project Stage-I • Use advanced tools for Implementation • Rectify/ Debug the design and Submit project report.	
Course Outcome	**Learner will be able to** • Debug/ Rectify the design incurred during implementation • Write Analysis, Results, Design in prescribed format • Learn the behavioral science by working in a group	

Pr**oject Guidelines:**

1. The students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I and should attempt solution to the problem.
2. Learner is allotted 12 hrs per week for the project work
3. Report should be prepared as per the guidelines issued by the University of Mumbai
4. Learners should be motivated to publish a paper based on the work in Conferences/students competitions
5. Project Groups: Learners can form groups not more than 4 (Four)

Faculty Load:

1. In semester VIII - 1 (One) periods of 1 hour each per week per project group
2. Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

Assessment:

Term Work:

The Term Work should be examined by approved internal faculty appointed by the head of the institute based on following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

Guidelines for Assessment of Project Stage- II

1. Project II should be assessed through a presentation jointly by Internal and External Examiners approved by the University of Mumbai
2. Project stage II should be assessed based on following points
    - Quality of problem selected
    - Clarity of Problem definition and Feasibility of problem solution
    - Relevance to the specialization / Industrial trends
    - Clarity of objective and scope
    - Quality of work attempted
    - Validation of results
    - Compilation of Project Report
    - Quality of Written and Oral Presentation

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML801	Biomedical Microsystems (BM)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML801	Biomedical Microsystems (BM)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML801	Biomedical Microsystems	01
Course Objectives	• To understand various fabrication techniques for MEMS devices and applying them for fabricating biomedical devices.	
Course Outcomes	**Learner will be able to…** • Select appropriate material, fabrication technique and packaging technique for given application • Simulate given microsystems to evaluate its performance	

Syllabus: Same as that of BMC801 Biomedical Microsystems(BM).

List of Experiments: (Any Three)

1. Simulation of scaling law
2. Crystal structure
3. Biosensors
4. Simulation of pressure sensors
5. Simulation of cantilever
6. Simulation of Microchannel
7. Simulation of Microvalve

8. Simulation of Micropump

List of Tutorials (Any Four)

1. Scaling Laws
2. Materials for MEMS
3. MEMS deposition techniques
4. MEMS etching techniques
5. Lithography
6. Surface characterization techniques
7. Micromachining
8. Softlithography
9. Micro Total Analysis systems
10. Drug delivery devices
11. MEMS packaging

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

Presentation based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 3 experiments and 4 Tutorials.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments and Tutorials) : 10 Marks
Presentation : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. "MEMS & MICROSYSTEMS Design and Manufacture", Tai-Ran Hsu, TATA Mcgraw-HILL.
2. "Fundamentals of Microfabrication" Marc Madou, CRC Press.

Reference Books:

1. "Fundamentals of BioMEMS and Medical Microdevices", Steven S. Saliterman, (SPIE Press Monograph Vol. PM153 by Wiley Interscience
2. "Microsystem Technology", W. Menz, J. Mohr, 0. Paul, WILEY-VCH, ISBN 3-527-29634-4
3. "Electro Mechanical System Design", James J. Allen, Taylor & Francis Group, LLC, ISBN-0-8247-5824-2, 2005
4. "MICROSYSTEM DESIGN",Stephen D. Senturia, KLUWER ACADEMIC PUBLISHERS,

eBook ISBN: 0-306-47601-0
5. "Introduction to Microfabrication", Sami FranssilaJohn Wiley & Sons Ltd, ISBN 0-470-85106-6
6. "Microelectromechanical Systems", Nicolae Lobontiu, Ephrahim Garcia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-387-23037-8
7. "BIOMEDICAL NANOTECHNOLOGY", Neelina H. MalschCRC PRESS, Taylor and Francis Group, ISBN 10: 0-8247-2579-4

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML802	Hospital Management (HM)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML802	Hospital Management (HM)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML802	Hospital Management	01
Course Objectives	• To understand the basic principles used for designing of various departments in the hospital. • To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve Hospitals. • Apply modern engineering and management principles to provide high quality of hospital care tin the community.	
Course Outcomes	**Learner will be able to** • Understand and apply finance management concepts and the processes and strategies needed in specific hospital sectors. • Understand the management structure and functions in hospital. Communicate effectively and develop their leadership and team building abilities. • Design the layout of clinical services and supportive departments in	

	the hospital. • Understand the roles and responsibilities of Biomedical Engineer in hospital. • Understand the functions of other Engineering services and axillary services • Understand and apply materials management and the purchase procedure in industry

Syllabus: Same as that of BMC802 Hospital Management (HM).

List of Experiments and Assignments: (Any Four Experiments and Any Four Assignments)

1. Design of Registration form of hospital.
2. Prepare budget using EXCEL sheet for purchase of hospital equipment.
3. Preparation of Comparative Statement of Equipment for purchase **(Any Two)**
4. Negotiations of the equipment in the comparative statement.
5. Design the layout of Out Patient Department in hospital.
6. Design the layout of In Patient Department in hospital.
7. Design the layout of Surgical Operation Theatre Complex in hospital.
8. Design the layout of Radiology Department in hospital.
9. Design the layout of Pathology Laboratory and Blood Bank Department in hospital.
10. Design the layout of Physiotherapy Department in hospital.
11. Design the layout of Central Sterile Supply Department in hospital.

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

Group Presentation based on the assigned topic by visiting a hospital.

Assessment:

Term Work:

Term work shall consist of minimum 4 experiments, 4 assignments and presentation.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Assignments) : 05 Marks
Presentations : 05 Marks
Attendance : 05 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Hospital Management by Dr. Pradyna Pai
2. Hospital Planning, Designing and Management: Kunders G D, Gopinath, A katakam (Private Pub Bangalore)

Reference Books:

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE Pub Bangalore
3. Careers in Biomedical : Shantanu Thatte.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 8041	Healthcare Informatics (HCI)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 8041	Healthcare Informatics (HCI)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL8041	Healthcare Informatics	01
Course Objectives	• To understand the healthcare interoperability semantic and syntactic. • To understand the standards of healthcare interoperability standards for Medical Images and Medical Messages	
Course Outcomes	**Learner will be able to** • Fabricate HL7 Messages • Edit and Compare DICOM file	

Syllabus: Same as that of BMDLO8041 Healthcare Informatics (HCI).

List of Experiments: (Any Seven)

1. To find term/ Concept and ID or Vocabulary codes

2. Identifying and Chapters of Health Level 7 for trigger Event and message types and message
3. Structure should be sent to cover each requirement
4. Reading and editing segment
5. Create Health Level 7 Message
6. Create Patient Information Database from Health Level 7 Messages
7. To Study DICOM Validation Tool (DVTK)
8. Edit DICOM File using hex-Editor\
9. Creating Database of a patient
10. Comparing DICOM file

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

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards), Springer Publication by Tim Benson
2. Digital Imaging and Communication in Medicine by Oleg S. Pianykh, Springer Publication
   CDA™ Book, By Keith Boone, Springer Publication

Reference Books:

1. Informatics in Medical Imaging, George C. Kagadis, Steve G. Langer CRC Press

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 8042	Robotics in Medicine (RIM)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 8042	Robotics in Medicine (RIM)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL8042	Robotics in Medicine	01
Course Objectives	• To introduce to basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning. • To introduce to various applications of Robots in Medicine.	
Course Outcomes	**A Learner will be able to** • Design basic Robotics system and formulate Kinematic, Inverse Kinematic motion planning solutions for various Robotic configurations. • Design Robotic systems for Medical application.	

Syllabus: Same as that of BMDLO8042 Robotics in Medicine (RIM).

List of Tutorials: (Any Seven)

1. Automation and Robots Classification
2. Specification, Notations
3. Direct Kinematics Dot and cross products
4. Five- axis robot, Four-axis robot, Six-axis robot(Direct Kinematics)
5. Five axis robots, Three-Four axis, Six axis robot(Inverse Kinematics)
6. Robot Vision Image representation
7. Segmentation
8. Applications in Biomedical Engineering ,Application in rehabilitation, Clinical and Surgery

9. Task Planning, Task level programming

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

Group Presentation on the latest technology in hospitals based on the topics covered in the syllabus. Learners are supposed carryout thorough literature survey, collect data and prepare their presentation.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Fundamentals of Robotics-Analysis and control, Robert Schilling, Prentice Hall of India.
2. Robotics, Fu,Gonzales and Lee, McGraw Hill
3. Introduction to Robotics, J.J,Craig,Pearson Education

Reference Books:

1. Robotics and AI, Staughard, Prentice Hall Of India.
2. Industrial Robotics - Grover, Wiess, Nagel, Oderey, , McGraw Hill.
3. Robotics and Mechatronics. Walfram Stdder,
4. Introduction to Robotics,Niku, Pearson Education.
5. Robot Engineering, Klafter, Chmielewski, Negin, Prentice Hall Of India.
6. Robotics and Control, Mittal, Nagrath, Tata McGraw Hill publications.

Course Code	Course Name	Teaching scheme			Credit assigned			
BMDLL	**Nuclear**	**Theory**	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**

8043	**Medicine (NM)**	**--**	**02**	**--**	**--**	**01**	**--**	**01**

Course Code	**Course Name**	**Examination Scheme**								
		Theory				**Term work**	**Pract.**	**Oral**	**Pract. / Oral**	**Total**
		Internal Assessment			**End sem**					
		Test 1	**Test 2**	**Avg.**						
BMDLL 8043	**Nuclear Medicine (NM)**	**--**	**--**	**--**	**--**	**25**	**--**	**25**	**--**	**50**

Course Code	**Course Name**	**Credits**
BMDLL8043	**Nuclear Medicine**	**01**
Course Objectives	• To enable the students to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment. • To keep the students abreast with the technological developments in the field of nuclear medicine.	
Course Outcomes	**Learners will be able to** • Understand essential physics of nuclear medicine such as basic concepts of radioactivity, its measurement, interaction with matter and radionuclide production. • Understand concepts of radiopharmaceuticals and various aspects of radiation safety. • Apply the principles of physics to understand working of various detectors and counting systems. • Study principle of operation of different scanning system and their quality control function. • Understand various Emission Tomography Techniques along with their Clinical Applications. • Understand concept of radionuclide therapy and the function of radiotherapy equipment.	

Syllabus: Same as that of BMDLL8043 Nuclear Medicine (NM).

List of Experiments and Tutorials: (Any Seven)

1. Interaction of Radiations with Matter

2. Classification of Detectors
3. Gas Filled Detectors
4. Scintillation and Solid State Detectors
5. Gamma Camera
6. Liquid Scintillation Technique
7. Tracers in Uptake Studies
8. Uptake Studies
9. Radiation Safety

Industry / Hospital Visits may be conducted.

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

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

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments and Tutorials) : 10 Marks
Presentation : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. J. Harbert and A.F.G. Rocha, *Textbook of Nuclear medicine*, Second Edition, Lea& Febiger.
2. B.R. Bairi, Balvinder Singh, N.C. Rathod and P.V. Narurkar, *Handbook of Nuclear medicine Instruments*, Tata McGraw – Hill.
3. Gopal B. Saha, *Fundamentals of Nuclear Pharmacy*, Springer Science+Business Media
4. Ramesh Chandra, *Introductory Physics of Nuclear Medicine*, Lea& Febiger.

References Books:

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