UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Biomedical Engineering

Fourth Year with Effect from AY 2021-22

(REV- 2019 'C' Scheme) from Academic Year 2022 – 23

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC:

Item No.:

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Fourth Year B.E. Biomedical Engineering**
2	Eligibility for Admission	**After Passing Third Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	**Under Graduation**
7	Pattern	**Semester**
8	Status	**Revised**
9	To be implemented from Academic Year	**With effect from Academic Year: 2022-2023**

Date

Dr. S. K. Ukarande   Dr Anuradha Muzumdar
Associate Dean   Dean
Faculty of Science and Technology   Faculty of Science and Technology
University of Mumbai   University of Mumbai

University of Mumbai, Biomedical Engineering, Rev 2022-23

Preamble

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 Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are 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. 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 and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande

Associate Dean

Faculty of Science and Technology

Member, Academic Council, RRC in Engineering

University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande

Associate Dean

Faculty of Science and Technology

Member, Academic Council, RRC in Engineering

University of Mumbai

Preface By BoS

Engineering is an innovative field, the origin of ideas leading to everything from automobile to aerospace, skyscrapers to sonar. **Biomedical Engineering** focuses on the advances that improve human health and health care at all levels. Biomedical engineering is an interdisciplinary field with application of the principles of Basic Sciences, Mathematics, Engineering fundamentals and Biology for problem-solving.

The curriculum is designed to meet the challenges by include new age courses on Machine Learning, Artificial Intelligence, Data Analytics and other emerging technologies, dismantling the walls between engineering and scientific disciplines. The key to generate a new paradigm shift for careers in Biomedical Engineering for the next generation of talented minds lies in imparting high-quality education in Engineering.

Every course in the curriculum lists the course objectives and course outcomes for the learners to understand the skills that the learner will acquire after completing that course. Program outcomes are the skills and knowledge that a student will acquire during the course of four years of this engineering program. In line with this, Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Biomedical Engineering of the University of Mumbai, I am happy to state here that, the Program Educational Objectives for undergraduate program were thoughtfully framed by faculty members from different affiliated institutes of the university. They are Heads of Departments and senior representatives from the Department of Biomedical Engineering.

The Program Educational Objectives for the undergraduate program in Biomedical engineering are listed below;

1. To prepare the learner with a sound foundation in the Human Physiology, Mathematics, Electronics, Computer Programming and engineering fundamentals.

2. To motivate the learner for self-learning, logical & analytical thinking and use of modern tools for solving real life problems.

3. To impart technical knowledge, competency skills, professional and ethical attitude, good leadership qualities to contribute in the field of healthcare.

4. To prepare the Learner for a successful career in healthcare industry such as sales & marketing, research & development, hospital administration and also to venture into higher education and entrepreneurship.

Board of Studies in Biomedical Engineering
Dr. Manali J. Godse   : Chairman
Dr. Prem C. Pandey   : Member
Dr. Mita Bhowmick   : Member
Dr. Mrunal R. Rane   : Member
Dr. Vaibhavi A. Sonetha : Member

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. /Tut.	Theory	Pract.	Total
BMC801	Hospital Management	3	--	3	--	3
BMDO801X	Department Optional Course – 5	3	--	3	--	3
BMDO802X	Department Optional Course – 6	3	--	3	--	3
BMIO801	Institute Optional Course - 2	3	--	3	--	3
BML801	Hospital Management Lab	--	2	--	1	1
BMDL801X	Department Optional Course – 5 Lab	--	2	--	1	1
BMP801	Major Project - II	--	12#	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
BMC801	Hospital Management	20	20	20	80	3	--	--	100
BMDO801X	Department Optional Course – 5	20	20	20	80	3	--	--	100
BMDO802X	Department Optional Course – 6	20	20	20	80	3	--	--	100
BMIO801	Institute Optional Course - 2	20	20	20	80	3	--	--	100
BML801	Hospital Management Lab	--	--	--	--	--	25	25	50
BMDL801X	Department Optional Course – 5 Lab	--	--	--	--	--	25	25	50
BMP801	Major Project - II	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**100**	**650**

# indicates work load of Learner (Not Faculty), for Major Project

Sem. VIII: Department Optional Course – 5

BMDO8011: Robotics in Medicine

BMDO8012: Healthcare Informatics

BMDO8013: Artificial Intelligence in Medicine

Sem. VIII: Department Optional Course – 6

BMDO8021: Biomedical Microsystems

BMDO8022: Medical Device Regulations

BMDO8023: Ergonomics

Sem. VIII: 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

Students group and load of faculty per week.

Mini Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : 1 hour per week per four groups

Major Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load :   In Semester VII – ½ hour per week per project group
                In Semester VIII – 1 hour per week per project group

	Semester – VIII	

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC801	Hospital Management (Abbreviated as HM)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dura tion (hrs)					
		Test 1	Test 2	Avg.							
BMC801	Hospital Management (HM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC801	Hospital Management	03
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. - To understand the overall functioning of various departments in the hospital.	
Course Outcomes	**Learner will be able to…** - Apply the management concepts used specifically in hospital. - Explain the management structure and its functions in hospital. - Demonstrate the knowledge about the principles of designing and commissioning of clinical services in the hospital. - Demonstrate the knowledge about the roles and responsibilities of Biomedical Engineer in hospital. - Demonstrate the knowledge about the functions of other Engineering and auxiliary services in the hospital. - Apply environment and waste management concepts in healthcare 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.	**07**
2	**Organization of the hospital and 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	**04**
3	**Clinical services: (Location, layout, equipment, personnel, and functions):** OUT patient, IN patient (wards), intensive care, pathology laboratory & blood bank, radiology, physiotherapy, surgical operation theatre, emergency (casualty).	**10**
4	**Biomedical engineering department: (Location, layout, equipment, personnel, and its main functions)** Roles and responsibilities of a biomedical engineer in hospitals, Equipment management: maintenance types: routine(preventive) and breakdown, maintenance contracts (CMC and AMC) Purchase management: Purchase system (centralized, decentralized, local purchase), types of purchase, purchase procedures: selection of suppliers, tendering procedures, analyzing bids, price negotiations Material's (store) management: Functions of store manager, materials handling, flow of goods/FIFO, inventory control**:** lead-time, buffer stock, reorder level, two bin system, EOQ	**09**
5	**Other engineering services:** Engineering services (electrical, mechanical and civil): responsibilities and functions. Hospital ventilation and air conditioning, medical gas system, hospital information system.	**05**
6	**Environment and waste management:** Hospital infection control, central sterile service department (CSSD), biomedical waste management, disaster management.	**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.

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
BMDO8011	Department Optional Course –5 Robotics In Medicine (Abbreviated as RIM)	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.							
BMDO8011	Department Optional Course –5 Robotics In Medicine (RIM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDO8011	Robotics In Medicine	03
Course Objectives	• To make the learner aware of fundamental concepts of Robotics • To make learner study direct and Inverse Kinematics of Robots • To make learner know the Trajectory and Motion planning. • To make the learner know the Biomedical applications of robotics	
Course Outcomes	**Learner will be able to…** • To describe direct and inverse kinematics of robots. • To describe workspace envelop and trajectory planning for robots • To apply various image processing tools for robotic manipulation • To implement motion planning solutions using various algorithms • To illustrate medical applications of robots	

Module No.	Contents	Hours
1	**Introduction:** Automation and robots, classification, application, specification and notations.	04
2	**Direct Kinematics:** Dot and cross products, co-ordinate frames, rotations, homogeneous coordinates, link co-ordinates, arm equation and arm matrix derivation (two axis, three axis and	10

		four axis SCARA), configuration of five axis and six axis robots (arm matrix derivation and equation not expected)	
3		**Inverse kinematics:** General properties of solutions of inverse kinematics, methods for finding solution, tool configuration vector and inverse kinematics solution for two axis, three axis and four axis robots. Workspace analysis, work envelope and examples, workspace fixtures, trajectory planning, pick and place operations, continuous path motion, interpolated motion, straight-line motion.	**08**
4		**Robot vision:** Image representation, template matching, polyhedral objects, shane analysis, segmentation (thresholding, region labelling, shrink operators, swell operators, Euler numbers, perspective transformation, structured illumination, camera calibration).	**06**
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.	**06**
6		**Applications in biomedical engineering:** Application in rehabilitation: clinical and surgery	**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. Fundamentals of Robotics-Analysis and control, Robert Shilling, Prentice Hall of India
2. Introduction to Robotics, Saeed B Niku, Pearson Education
3. Robotics, Fu, Gonzales and Lee, McGraw Hill, SecondEdition,2011
4. "Introduction to Robotics–Mechanics &Control" John J. Craig, Pearson Education, India, Third Edition, 2009

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, Mc Graw Hill, NewYork, 2008
4. Robot Engineering, Klafter, Chmielewski, Negin. Prentice Hall Of India.
5. 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
BMDO8012	Department Optional Course –5 Healthcare Informatics (Abbreviated as HCI)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract / Oral	Total
		Internal Assessment			End sem	Dura tion (hrs)					
		Test 1	Test 2	Avg.							
BMDO8012	Department Optional Course –5 Healthcare Informatics (HCI)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDO8012	Healthcare Informatics	03
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	**Learners 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.	**05**
2.	**HL7 Version 2 (Part-I)** Message syntax, delimiters, segment definition, message header MSH, patient identification details (PID), patient visit (PV1), request and specimen details (OBR), result details (OBX).	**04**
3.	**HL7 Version 2 (Part-II)** Z-Segments, data, simple data types, complex data types, codes and identifiers, names and addresses, other complex data types.	**04**
4.	**DICOM standard:** Introduction, DICOM Grammar: VRs, DICOM data dictionary, DICOM objects, DICOM information hierarchy, modules, IODs and IEs.	**07**
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.	**09**
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:

Textbooks:
1. Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards) by Tim Benson, Springer Publication.
2. Digital Imaging and Communication in Medicine (DICOM) by Oleg S. Pianykh, Springer Publication.
3. The CDATM 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			
	Department Optional Course –5 Artificial Intelligence in Medicine (Abbreviated as AIM)	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO8013		03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Dura tion (hrs)					
		Test 1	Test 2	Avg.							
BMDO8013	Department Optional Course –5 Artificial Intelligence in Medicine (AIM)	20	20	20	80	3	--	--	--	--	100

Course Code	Course Name	Credits
BMDO8013	**Artificial Intelligence in Medicine**	03
Course Objectives	• To understand basics of Artificial Intelligence, Intelligent Agents. • To conceptualize search techniques. • To understand exert system in Artificial Intelligence	
Course Outcomes	**Learner will be able to…** • Develop a basic understanding of intelligent agents in artificial intelligence • Choose an appropriate problem-solving method and knowledge representation technique • Comprehend the concept of propositional logic • Understand Reasoning and Knowledge Representation • Develop basic understanding of expert system and it's applications • Learn AI applications in health care	

Module	Contents	Hours
1	**Basics of Artificial Intelligent:** Definition and concept of Artificial Intelligence, stages of AI, intelligent agents in artificial intelligence, foundations of AI and applications, current trends in AI	04
2	**Problem Spaces, and Search:** Breadth first search, depth first search techniques, iterative deepening, bidirectional search, best first search, Heuristic search, Hill Climbing, A* Search, **Problem reduction and game playing:** Introduction, problem reduction, game playing, alphabeta pruning, two-player perfect information games	10
3	**Logic concepts:** Introduction, propositional calculus, propositional logic, natural deduction system, axiomatic system, semantic tableau system in proportional logic, resolution refutation in proportional logic, predicate logic	07
4	**Knowledge Representation:** Problems in representing knowledge, knowledge representation using propositional and predicate logic, logical consequences, syntax and semantics of an expression, semantic Tableau. Forward and backward reasoning. Proof methods, substitution and unification, conversion to clausal form, normal forms, resolution, refutation, deduction, theorem proving, inferencing, monotonic and non-monotonic reasoning.	08
5	**Expert system and applications:** Introduction phases in building expert systems, expert system versus traditional systems, rule-based expert systems blackboard systems truth maintenance systems, application of expert systems	06
6	**AI in Healthcare:** Benefits of AI in medicine, AI and Medical visualization, Medical Expert system, Applying AI to EHR Data, Artificial Intelligence in Medical Imaging	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.

Books Recommended:

Text Books:

1. Stuart J. Russell and Peter Norvig, "***Artificial Intelligence: A Modern Approach***", Fourth Edition" Pearson Education, 2020.
2. Saroj Kaushik, "***Artificial Intelligence***", Cengage Learning, First edition, 2011
3. Itisha Gupta and Garima Nagpal, "***Artificial Intelligence and Expert System***", Laxmi Publications, 1st Edition 2018

Reference Books:

1. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.

2   Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill
     Publication
3   Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4   Elaine Rich and Kevin Knight, "*Artificial Intelligence*", Third Edition, McGraw
     Hill Education,2017.

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
4. Remaining questions will be randomly selected from all the modules depending the weightage.

Useful Links:
1   https://nptel.ac.in/courses/106/105/106105078/
2   https://archive.nptel.ac.in/courses/106/105/106105077/#
3   https://nptel.ac.in/courses/106/105/106105079/

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO8021	Department Optional Course –6 Biomedical Microsystems (Abbreviated as BM)	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.							
BMDO8021	Department Optional Course –6 Biomedical Microsystems (BM)	20	20	20	80	3	--	--	--	--	100

Course Code	Course Name	Credits
BMDO8021	Biomedical Microsystems	03
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 • Analyse 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:**	**06**
	• Difference between Microelectronics and MEMs, Block diagram of MEMS and BIOMEMS, examples. Introduction to generalised processes used.	
	• Clean room: definition, classification, air flow system	
	• Safety in handling hazardous materials in clean room	
	• Scaling Laws in Miniaturization	
	• Substrates and Wafers: CZ process and float zone process, Wafer types	
	• Materials: Properties and applications of single crystal silicon, SiO2, Si3N4, SiC, Polysilicon, Glass	
	• Wafer cleaning processes: RCA, Piranha	
	• Positive and negative photoresist, mask, material properties of PMMA, SU8	
	• Different projection systems,	
	• Surface characterization techniques: AFM, SEM, TEM, Ellipsometer, Profilometer	
2.	**MEMS Fabrication Processes**	**07**
	• Photolithography: Definition, steps, light sources (UV, DUV, EUV)	
	• PVD: definition, types: Evaporation (Thermal and E-beam) and Sputtering (DC and RF), advantages, disadvantages, Material properties of Al	
	• CVD: definition, reaction steps, types: APCVD, LPCVD, PECVD, and HWCVD, 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	
3.	**Microfabrication Techniques**	**07**
	• Bulk micromachining: definition, advantages and disadvantages, Examples: pressure sensor, dissolved wafer process	
	• Surface micromachining: definition, advantages and disadvantages Examples: pressure sensor, cantilever	
	• Non polysilicon surface micromachining: SOI fabrication	
	• LIGA: definition, process steps, examples, advantages and disadvantages	
	• X-ray lithography: Synchrotron radiation, X-ray mask	
	• Molding techniques: Injection, compression, hot embossing	
	• Soft lithography: Definition, SAMs, Types: Micro Contact Printing, Material properties of PDMS, Gold, Conducting polymers	
	• Micro molding techniques: Replica molding, Microtransfer molding, Micromolding in capillaries and Solvent-assisted micromolding	
4.	**MICRO TOTAL ANALYSIS SYSTEMS (µTAS)**	**07**
	• 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	**06**	
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

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 depending the weightage.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO8022	Medical Devices Regulations (Abbreviated as MDR)	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.							
BMDO8022	Medical Devices Regulations (MDR)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDO8022	**Medical Devices Regulations**	03
Course Objectives	- To familiarize the learners with the regulatory aspects of medical devices and instruments. - To keep the learners abreast with the technological developments in the field of Medical devices regulatory affairs.	

Course Outcomes	Learner will be able to:
	• Discuss credibility & authorities of approvals, medical devices life cycle, risk based classification and risk based approach for regulatory controls.
	• Explain principles of safety and effectiveness, quality management system, Various standards (American, European, BIS), risk management, cyber security and clinical evaluation.
	• Describe technical documentation required by regulators, essential requirements checklist, risk management summary report, manufacturing information, regulated product submissions and regulatory submission repository.
	• Highlight premarket phase like design controls, information management during premarket phase, R&D planning stage, design & development process stage and product identification & traceability.
	• Perform regulatory submissions, approvals and registration.
	• Launch the product, do post market surveillance, look after product obsolescence, oversee quality management system and regulatory system & processes.

Module	Contents	Hours
1.	**Overview of regulatory framework for medical devices:** Credibility and authority of approvals, medical devices life cycle, risk-based classification, risk-based approach for regulatory controls. Introduction to International Regulatory Requirements & Device Pathways.	**07**
2.	**Safety & Effectiveness:** Principles of safety and effectiveness, Quality management system, Standards, Risk management, Cybersecurity, Clinical evaluation. Classification of Biomedical Instruments, based on safety standards, Approach to Bioethics	**07**
3.	**Technical Documentation:** Technical documentation required by regulators, Essential requirements checklist, Risk management summary report, Manufacturing information, Regulated product submissions, Regulatory submission repository	**07**
4.	**Premarket phase:** Design controls, Information management during premarket phase, R&D planning stage, Design & development process stage, product identification & traceability, Case study	**06**
5.	**Regulatory submissions, approvals and registration**: Administrative provisions, regulatory submission and approval, International scenario	**06**
6.	**Post market phase:** Product launch, continued regulatory compliance, Post market surveillance, Product obsolescence, Quality management system, Regulatory system, and processes. Types of medical device audits. Medical device Compliance Audit	**06**

Internal 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:
Textbooks:
1. Medical device regulatory practices, Val Theisz, PAN Satnford Publishing
2. Handbook of Medical Device regulatory affairs in Asia, edited by Jack Wong and Raymond KY Tong
3. Medical Device Regulations: Global Overview and Guiding Principles, Michael Cheng, World Health Organization.

Reference Books:
1. Daniel A. Vallero - Biomedical Ethics for Engineers_ Ethics and Decision Making in Biomedical and Biosystem Engineering (Biomedical Engineering Series)-Academic Press
2. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
3. Ethics for Biomedical Engineers, Jong Yong Abdiel Foo, Stephen J. Wilson, Andrew P. Bradley, Winston Gwee, Dennis Kwok-Wing Tam (auth.) , Springer-Verlag New York

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 depending the weightage.

Course Code	Course Name	Teaching scheme			Credit assigned			
BMDO8023	Department Optional Course –6 Ergonomics (Abbreviated as ERG)	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
		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.							
BMDO8023	Department Optional Course –6 Ergonomics (ERG)	20	20	20	80	3	--	--	--	--	100

Course Code	Course Name	Credits
BMDO8023	Ergonomics	03
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 • Analyse 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 Ergonomics** • Definition of Ergonomics and its application and overview. • Ergonomics in systems design, and steps to performing a task analysis. In class practice performing a task analysis.	**08**
2.	**Design Man Machine Environment System Design** • Overview of Human body and its sub systems. • Understanding musculoskeletal system and its function in terms of manual activities • Understanding nervous system, human sensory organs and their limitations. • Basic Bio mechanics and its application in design	**09**
3.	**Muscle Use and Anthropometry and Workspace** • Anthropometry and its application • Issues of cognition, perception and performance. • Study of work posture and its impact on human performance. • Physical environment and their impact on human performance • Muscular work including dynamic and static work, nervous control of movement, skilled work and ways to improve work efficiency. • Use of anthropometric data in ergonomics. • Principles of workspace design, including seated work, standing work, work reaches and working heights, the office environment and visual work	**10**
4.	**Occupational stress and Musculoskeletal disorders; Safety and health issues Cognitive aspects of user-system interaction:** • Perception, information processing, user behaviour, error and risk perception;	**04**
5.	**Principles of human factors in visual communication** • Visual display in different planes- static shape, size, font type and dynamic characters of display	**04**
6	**Environmental factors influencing human performance** • Participatory ergonomics aspects	**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.

Books Recommended:

Text Books:

1. Bridger, R., Introduction to Ergonomics, 3rd Ed., CRC Press, Taylor & Francis Group, 2009.
2. Sanders, M., McCormick, E., Human Factors in Engineering and Design, 7th Ed., McGraw-Hill International Editions: Psychology Series, 2013
3. Wicknes, C., Gordon, S., Liu, Y., and Gordon-Becker, S., An Introduction to Human Factors Engineering, Longman, New York, 2015
4. Chakrabarti, D., Indian Anthropometric Dimensions for ergonomic design practice, National Institute of Design, Ahmedabad, 1997
5. Salvendy, G. (ed.), Handbook of Human Factors and ergonomics, 4th Ed., John Wiley & Sons, Inc., 2012

6. Dul, J., Weerdmeester, B., Ergonomics for beginners, a quick reference guide, 3rd Ed., CRC Press, Taylor & Francis Group, 2008.

Reference Books:

1. J. Dul, and B. Weerdmeester, Ergonomics for beginners, a quick reference guide, Taylor & Francis, 1993.
2. E.Grandjean : Fitting the task to the man, Taylor & Francis Ltd.1980.
3. J. Ansel, Visual ergonomics in the workplace, Taylor & Francis, London, 1998
4. W. Karwowski and W. S. Marras, The Occupational Ergonomics handbook, CRC Press, New York, 1999.
5. M. S. Sanders and E. J. McCormick, Human Factors in Engineering and Design, McGraw-Hill, Inc., 1993.
6. K. Kroemer, H. B. Kroemer and K. E. Kroemer, Ergonomics- How to Design for Easy and Efficiency, Prentice Hall Englewood Cliffs, NJ 07632, 1994.

Theory Examination:

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

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO 8021	**Project Management**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO7019	**Development Engineering**	20	20	20	80	3	--	--	100

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	**Upon successful completion of this course, the 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
1	**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
2	**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
3	**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

4	**Planning Projects:** Crashing project time, Resource loading and levelling, 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
5	**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 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,		08
6	**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.		06

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO 8022	**Finance Management**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO 8022	**Finance Management**	20	20	20	80	3	--	--	100

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	**Upon successful completion of this course, the learner will be able to:** • Understand Indian finance system and corporate finance • Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hours
1	**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
2	**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

3	**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
4	**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
5	**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

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.

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8023	**Entrepreneurship Development and Management**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO8023	**Entrepreneurship Development and Management**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• To acquaint with entrepreneurship and management of business • Understand Indian environment for entrepreneurship • Idea of EDP, MSME
Course Outcomes	**Upon successful completion of this course, the 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
1	**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
2	**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
3	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05

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4	**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
5	**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
6	**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

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

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8024	**Human Resource Management**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO8024	**Human Resource Management**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

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 of today's organizations • To familiarize the students about the latest developments, trends & different aspects of HRM • To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Understand the concepts, aspects, techniques and practices of the human resource management. • Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective. • Gain knowledge about the latest developments and trends in HRM. • Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hours
1	**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
2	**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues	07

	• 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 Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour 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	
3	**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
4	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment – Job Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning Training & Development: Identification of Training Needs, Training Methods	05
5	**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
6	**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

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, 2016, Pearson Publications

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3, then part (b) will, be from any module other than module 3)
4. Only **Four questions need to be solved**.

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Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8025	**Professional Ethics and Corporate Social Responsibility (CSR)**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO8025	**Professional Ethics and Corporate Social Responsibility (CSR)**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• To understand professional ethics in business • To recognized corporate social responsibility
Course Outcomes	**Upon successful completion of this course, the 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
1	**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
2	**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
3	**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

4	**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
5	**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
6	**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

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; Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8026	**Research Methodology**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO8026	**Research Methodology**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

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	**Upon successful completion of this course, the 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	Hours
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** **2.1**. Basic Research **2.2**. Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5**. Empirical Research **2.6** Qualitative and Quantitative Approaches	07
03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07

04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. 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** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	04

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

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8027	**IPR and Patenting**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO8027	**IPR and Patenting**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

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	**Upon successful completion of this course, the 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) active in 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.	05

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 Publication, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

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. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 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 and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 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, Priti Mathur, Anshul Rathi**,** 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

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO 8028	**Digital Business Management**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO 8028	**Digital Business Management**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• To familiarize with digital business concept • To acquaint with E-commerce • To give insights into E-business and its strategies
Course Outcomes	**Upon successful completion of this course, 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, Cryptography, 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	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

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, VinocenzoMorabito, 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-enOECD Publishing

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract./Tut.	Total
ILO8029	**Environmental Management**	**3**	**--**	**3**	**--**	**3**

Course code	Course Name	Examination Scheme							
		Theory					Term Work	Oral	Total
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Avg					
ILO8029	**Environmental Management**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• Understand and identify environmental issues relevant to India and global concerns • Learn concepts of ecology • Familiarise environment related legislations
Course Outcomes	**Upon successful completion of this course, the 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
1	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
2	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
3	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
4	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
5	Total Quality Environmental Management, ISO-14000, EMS certification.	05
6	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

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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 Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML801	**Hospital Management (Abbreviated as HM lab)**	--	**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	**Hospital Management (HM Lab)**	--	--	--	--	**25**	--	**25**	--	**50**

Course Code	Course Name	Credits
BML801	**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. • To understand the overall functioning of various departments in the hospital.	
Course Outcomes	**Learner will be able to…** • Apply the management concepts used specifically in hospital. • Explain the management structure and its functions in hospital. • Demonstrate the knowledge about the principles of designing and commissioning of clinical services in the hospital. • Demonstrate the knowledge about the roles and responsibilities of Biomedical Engineer in hospital. • Demonstrate the knowledge about the functions of other Engineering and auxiliary services in the hospital. • Apply environment and waste management concepts in healthcare industry.	

Syllabus: Same as that of BMC801 Hospital Management (HM).

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

1. Design of Registration form of hospital.
2. Prepare an organization chart for multi-speciality hospital
3. Prepare budget using EXCEL sheet for purchase of hospital equipment.
4. Preparation of Comparative Statement in Excel for purchase of medical equipment. **(Any Two)**
5. Design the layout of Outpatient Department in hospital.
6. Design the layout of ICU 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.

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.

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.

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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDL8011	Robotics In Medicine Laboratory (Abbreviated as RIM Lab)	--	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.						
BMDL8011	Robotics In Medicine Laboratory (RIM Lab)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDL8011	**Robotics In Medicine Laboratory**	01
Course Objectives	• To make the learner aware of fundamental concepts of Robotics • To make learner study direct and Inverse Kinematics of Robots • To make learner know the Trajectory and Motion planning. • To make the learner know the Biomedical applications of robotics	
Course Outcomes	• To describe direct and inverse kinematics of robots. • To describe workspace envelop and trajectory planning for robots • To apply various image processing tools for robotic manipulation • To implement motion planning solutions using various algorithms • To illustrate medical applications of robots	

Syllabus: Same as that of BMDO8011 Hospital Management (HM).

List of Experiments: (Any Seven)

Students can perform any other experiment/Mini project/ Seminar/ Scholarly paper review based on the theory syllabus. The coding can be done in MATLAB/SCILAB/Python/C

1. Fundamental and Composite Rotations of Mobile frame with respect to fixed frame
2. Homogeneous Transformations and Screw Transformations
3. Kinematic configurations and Link Coordinate Transformations matrix(Arm Matrix)
4. Direct Kinematics of 2-3 axis Planar Robot and find the location of Tool tip.
5. Direct Kinematic Analysis of 4,5 Axis Robot
6. Inverse Kinematics of robots and prove that there are multiple ways to reach a particular point.
7. Develop Work Envelop for 2,3 axis Robot
8. To study segmentation using edge detection technique
9. Straight line trajectory planning-BDA Algorithm
10. Template Matching
11. Gross motion planning is a part of task planning of robot. Suggest any method of gross motion planning so that the task can be completed without hitting obstacles
12. Presentation/ Seminar/Case study on Biomedical Application of robotics

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 (Journal / Mini project): 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.

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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDL8012	Department Optional Course – 5 Lab Healthcare Informatics Laboratory (Abbreviated as HCI Lab)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract / Oral	Total
		Internal Assessment			End sem exam	Dura tion (hrs)					
		Test 1	Test 2	Avg.							
BMDL8012	Department Optional Course – 5 Lab Healthcare Informatics Laboratory (HCI Lab)	--	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDL8012	Healthcare Informatics Laboratory	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	**Learners will be able to:** • Fabricate HL7 Messages • Edit and Compare DICOM file.	

Syllabus: Same as that of BMDO8012 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:

Textbooks:
1. Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards) by Tim Benson, Springer Publication.
2. Digital Imaging and Communication in Medicine (DICOM) by Oleg S. Pianykh, Springer Publication.
3. The CDATM 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
BMDL8013	Department Optional Course – 5 Lab Artificial Intelligence in Medicine (Abbreviated as AIM)	--	02	--	--	1	--	1

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.							
BMDL8013	Department Optional Course – 5 Lab Artificial Intelligence in Medicine (AIM Lab)	--	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDL8013	**Artificial Intelligence in Medicine**	01
Course Objectives	• To understand the basic techniques to build intelligent systems • To apply appropriate search techniques used in problem solving	
Course Outcomes	**Learner will be able to…** • Identify languages and technologies for Artificial Intelligence • Understand and implement searching techniques • Create a knowledge base • Design and implement expert systems	

Suggested List of Experiments

Sr. No.	Title of Experiment
1.	Introduce AI programming language
2.	Knowledge representation and create knowledge base
3.	One case study on AI applications published in IEEE/ACM/Springer or any prominent journal.
4.	Assignments on State space formulation and PEAS representation for various AI applications
5.	Uninformed search methods.
6.	Informed search methods.
7.	Game playing algorithms.
8.	First order Logic

Note: Any other practical/assignments covering the syllabus topics and subtopics can be conducted.

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/assignments): 10 Marks
Laboratory work (Journal) : 10 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   Stuart J. Russell and Peter Norvig, "***Artificial Intelligence: A Modern Approach***", Fourth Edition" Pearson Education, 2020.
2   Saroj Kaushik, "***Artificial Intelligence***", Cengage Learning, First edition, 2011
3   Itisha Gupta and Garima Nagpal, "***Artificial Intelligence and Expert System***", Laxmi Publications, 1st Edition 2018

Reference Books:

1   Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
2   Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
3   Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4   Elaine Rich and Kevin Knight, "***Artificial Intelligence***", Third Edition, McGraw Hill Education,2017.

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

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMP801	Major Project - 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.						
BMP 801	Major Project - II	--	--	--	--	50	--	--	100	150

Course Code	Course Name	Credits
BMP801	Major Project-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 behavioural science by working in a group	

Project 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