AC :

Item No.:

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
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

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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

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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

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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

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Program Structure for Fourth Year Engineering
Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
BMC701	Biomedical Instrumentation – III	3	--	3	--	3
BMC702	Machine Learning	3	--	3		3
BMDO701X	Department Optional Course – 3	3	--	3	--	3
BMDO702X	Department Optional Course – 4	3	--	3	--	3
BMIO701	Institute Optional Course – 1	3	--	3	--	3
BML701	Biomedical Instrumentation – III Lab	--	2	--	1	1
BML702	Machine Learning Lab	--	2	--	1	1
BMDL701X	Department Optional Course – 3 Lab	--	2	--	1	1
BMP701	Major Project - I	--	6#	--	3	3
Total		**15**	**12**	**15**	**6**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg					
BMC701	Biomedical Instrumentation – III	20	20	20	80	3	--	--	100
BMC702	Machine Learning	20	20	20	80	3	--	--	100
BMDO701X	Department Optional Course – 3	20	20	20	80	3	--	--	100
BMDO702X	Department Optional Course – 4	20	20	20	80	3	--	--	100
BMIO701	Institute Optional Course – 1	20	20	20	80	3	--	--	100
BML701	Biomedical Instrumentation – III Lab	--	--	--	--	--	25	25	50
BML702	Machine Learning Lab	--	--	--	--	--	25	25	50
BMDL701X	Department Optional Course – 3 Lab	--	--	--	--	--	25	25	50
BMP701	Major Project - I	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	--	**125**	**75**	**700**

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

Sem. VII: Department Optional Course – 3

BMDO7011: Biological Modeling and Simulation
BMDO7012: Bioinformatics
BMDO7013: IoT based Systems

Sem. VII: Department Optional Course – 4

BMDO7021: Rehabilitation Engineering
BMDO7022: Lasers and Fibre Optics
BMDO7023: Networking and Information Systems in Medicine

Sem. VII: Institute Level Optional Course –I

ILO1011: Product Lifecycle Management
ILO1012: Reliability Engineering
ILO1013: Management Information System
ILO1014: Design of Experiments
ILO1015: Operation Research
ILO1016: Cyber Security and Laws
ILO1017: Disaster Management and Mitigation Measures
ILO1018: Energy Audit and Management
ILO1019: Development Engineering

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Semester – VII

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC701	Biomedical Instrumentation- -III (Abbreviated as BMI-III)	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.							
BMC701	Biomedical Instrumentation- -III (BMI-III)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC701	Biomedical Instrumentation- -III	03
Course Objectives	• To understand the basic principles and working of life Saving Equipment. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcomes	**Learner will be able to…** • Distinguish between the types of pacemakers on the basis of ICHD code and analyze the various circuits. • Apply the knowledge of electronics to analyze defibrillator circuits. • Explain the importance of use of Anesthesia machine and Capnograph during Surgery. • Explain the basic principle, working and applications of surgical equipment with safety aspects. • Explain the importance of measurement of oxygen saturation in human body and application of heart lung machine during surgery.	

Module	Contents	Hours
1	**Cardiac Pacemakers** Need for a pacemaker, modes of operation, classification codes for pacemaker, external and implantable pacemaker, programmable pacemaker, Power sources for pacemakers, leads and electrodes, recent developments of Implantable Pacemakers.	09
2	**Cardiac Defibrillator** Need for defibrillator, D C defibrillator, modes of operation and electrodes, performance aspects of dc-defibrillator, implantable defibrillator, cardioverter.	08
3	**Physiotherapy equipments** Basic principle, working and technical specifications of 1.Shortwave Diathermy 2.Ultrasonic therapy unit 3. Nerve and Muscle Stimulator.	06
4	**Surgical equipment** Operation theatre Lights and Table. Surgical Diathermy machine, automated electrosurgical systems, electrodes used with surgical diathermy, safety aspects in electronic surgical units.	08
5	**Heart Lung machine** Heart Lung Machine and types of oxygenators	04
6	**Oximeters** Basics of oximeter, In-vitro and In-vivo oximetry, ear oximetry, pulse oximetry, skin reflectance oximeters, intravascular oximeters,	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. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements: Leslie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

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

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
BMC702	Machine Learning (Abbreviated as ML)	03	--	--	03	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC702	Machine Learning (ML)	20	20	20	80	3	--	--	--	--	100

Course Code	Course Name	Credits
BMC702	Machine Learning	03
Course Objectives	• To build a strong base in artificial intelligence through algorithm development. • To develop competency in logical thinking, computer programming and knowledge application. To train and motivate for higher education and research in order to make contribution to state of the art health care for all	
Course Outcomes	**Learner will be able to…** • Understand the fundamental techniques and applications in neural networks, deep learning and machine learning • Understand supervised and unsupervised learning, backpropogation and gradient descent algorithms • Understand and implement efficient computational techniques using neural networks, deep learning and machine learning Design and implementation of neural network models with deep learning and machine learning will be strong base for dsigning artificial intelligent systems	

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Module	Contents	Hours
1	**Learning methods:** Introduction , types of learning, supervised learning, unsupervised learning, statistical learning, reinforcement learning, elements of reinforcement learning, model-based learning, temporal difference learning, linear regression, least squares, linear regression for polynomial regression tasks, logistic regression, model selection and validation,	06
2	**Clustering:** Introduction, mixture densities, k-means clustering, expectation-maximization algorithm, supervised learning after clustering, spectral clustering, hierarchical clustering, choosing the number of clusters. **Decision Trees:** Introduction, univariate trees, rule extraction from trees, learning rules from data, multivariate trees, clustering, overfitting and evaluation	06
3	**Design and analysis of machine learning experiments:** Introduction, factors, response, and strategy of experimentation, response surface design, randomization, replication, and blocking, guidelines for machine learning experiments, cross-validation and resampling methods, measuring classifier performance	06
4	**Introduction of artificial neural networks:** structure and function of a biological neurons, artificial neuron models, concepts of neural network, single layer and multilayer preceptor, structure of an ANN, feed-forward neural network, gradient descent, back propagation, architectures of neural networks, optimisation of neural network model	07
5	**Architecture and training the ANN:** Type of learning the neural network, training of a single-layer neural network, delta rule, designing ANN models, radial basis function, overview of learning rules and parameters, activation functions, multilayer feed forward network, backpropagation networks, architecture, radial basis function network	07
6	**Fundamentals of deep networks:** Deep Learning, architectural principles of deep networks, parameters, layers, loss function , optimization algorithms, hyper parameters, building blocks of deep networks, architectures of deep networks, convolutional neural networks, architecture of convolutional neural networks, input layers, convolutional layers, pooling layers, fully connected layers, recurrent neural networks, architecture of recurrent neural network	07

Assessment

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

Books Recommended:

Text books

1. Introduction to Machine Learning, 3rd edition, Ethem Alpaydin, PHI Learning Private Limited, New Delhi, 2015
2. Deep Learning by Josh Patterson and Adam Gibson, O'Reilly Media, Inc., Gravenstein Highway North, Sebastopol CA, 2017
3. Neural Networks and Learning Machines Third Edition, Simon Haykin, Pearson, Prentice Hall, 2009

Reference books

1. Machine learning in Action, Peter Harrington, dreamtech Press, New Delhi, 2012
2. Machine learning, Tom M, Mitchell, Mc Graw Hill Education(India) Private Limited New Delhi, 2013

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Useful Links:

1. *Course 1:* Introduction to Machine Learning
   https://nptel.ac.in/courses/1061061392.
2. *Course 2:* Introduction to Machine Learning
   https://onlinecourses.nptel.ac.in/noc22_cs29/preview

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.

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Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BMDO7011	Biological Modeling and Simulation (Abbreviated as BMS)	3	--	-	3	--	-	3

Course Code	Course Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BMDO7011	Biological Modeling and Simulation	20	20	20	80	-	-	-	100

Course Code	Course Name	Credits
BMC702	Biological Modeling and Simulation	03
Course Objectives	• To understand basic concepts of modeling for designing biological model. • To simulate physiological processes for better understanding. • To develop competency in terms of logical thinking, programming and application skills • To train and motivate students for pursuing higher education and research for developing cutting edge technologies.	
Course Outcomes	**A learner will be able to:** • Categorise different types of biological models. • Develop a model of a neuron using Hodgkin Huxley exp setup. • Differentiate a spindle receptor and Golgi tendon bodies. • Design a quantitative model for eye movement system. • Understand a basic model of a thermoregulatory system. • Understand the behaviour of immune system	

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Module	Contents	Time
1	**Physiological modeling**: Steps in modeling, purpose of modeling, lumped parameter models, distributed parameter models, compartmental modeling, modeling of circulatory system.	04
2	**Model of neurons:** Biophysics tools, Nernst Equation, Donnan Equilibrium, active transport (Pump) GHK equation, action potential, voltage clamp, channel characteristics, Hodgkin-Huxley conductance equations, simulation of action potential, electrical equivalent model of a biological membrane, impulse propagation- core conductor model, cable equations.	11
3	**Neuromuscular system:** Modeling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome.	06
4	**Eye movement model:** Four eye movements, quantitative eye movement models, validity criteria.	06
5	**Thermo-regulatory systems:** Thermoregulatory mechanisms, electrical model of thermoregulatory system, controller model, validation and application.	06
6	**Modeling of other physiological systems.** **Modeling the immune response:** Behavior of the immune system, linearized model of the immune response. Modeling of insulin glucose feedback system and Pulsatile insulin secretion	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. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

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

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Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO7012	Department Optional Course – 3 Bioinformatics (Abbreviated as BI)	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.							
BMDO7012	Department Optional Course – 3 Bioinformatics (BI)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDO7012	Bioinformatics	03
Course Objectives	• The course introduces the students to the field of Bioinformatics. • To make students aware about the methods to characterize and manage the different types of biological data. • To introduce students to the basics of sequence alignment and analysis.	
Course Outcomes	**Learner will be able to** • Get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis. • Apply knowledge of basic principles of mathematics and statistics. • Apply existing software effectively to extract information from large databases and to use this information in computer modelling • Apply problem-solving skills to multivariate methods in bioinformatics • Search and apply bioinformatics tools to analyse and interpret biological data	

Module	Contents	Hours
1	**Introduction to bioinformatics and biological databases:** Basic principles of genetics**, c**ells, DNA and chromosome, genes and the genome, DNA sequencing, proteomics, discovery of gene sequence. Human genome project, biological databases and their classification, genome sequence databases, protein structure databases, composite databases.	**08**
2	**Statistical methods used in bioinformatics:** Basic statistical modelling and Bayesian inference, gene expression and microarray analysis, sequence alignment, sequence pattern discovery, combining sequence and expression information.	**10**
3	**Algorithms in bioinformatics:** Introduction, dynamic programming and sequence alignment, Needleman–Wunsch algorithm, Greedy algorithms for Genome rearrangement, string algorithm, breakpoint graph, approximation algorithm, FASTA and BLAST algorithms..	**08**
4	**Multivariate Methods in Bioinformatics:** Multivariate normal distribution, multivariate hypothesis tests, principle component analysis, orthogonal factor model, linear discriminant analysis, classification methods, Naïve Bayes classification.	**06**
5	**Applications and tools of bioinformatics:** Sequence alignment and dotplot, DNA sequence analysis, protein sequence analysis, database similarity search, phylogenic analysis and tree construction, gene, protein and tissue microarray.	**07**

Assessment:

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Recommended Online Courses (optional):

1. "Bioinformatics and Computational Biology" offered by IIT Kanpur **https://piazza.com/iitk.ac.in/secondsemester2018/bse322a/**
2. "Network Analysis in Systems Biology" offered by Icahn School of Medicine at Mount Sinai, in New York City **https://www.coursera.org/learn/network-biology**
3. "Bioinformatics: Introduction and Methods" from Peking University. **https://www.coursera.org/learn/bioinformatics-pku**
4. "Biology Meets Programming : Bioinformatics for Beginners", offered by UC San Diego **https://www.coursera.org/learn/bioinformatics**

Books Recommended:

Text books:

1. Basics of Bioinformatics, Rui Jiang, Xuegong Zhang, Michael Q. Zhang, Springer, E-book.
2. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 2002, First Edition.

Reference Books:

1. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

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

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Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO7013	IoT Based Systems (Abbreviated as IoT)	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.							
BMDO7013	IoT Based Systems (IoT)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDO7013	IOT Based Systems	03
Course Objectives	• Learn the concepts of IOT • Identify different technologies and schemes • Learn different applications in IOT • Learn different protocols used in IOT • Learn how to analyze the data in IOT	
Course Outcomes	**Learner will be able to** • Apply the concepts of IOT • Identify and select different technologies and scheme for IOT applications • Apply IOT to different applications • Analyze and evaluate protocols used in IOT systems • Analyze dataflow in IOT systems	

Module	Contents	Hours
1	**Introduction:** History of IoT, Objects in IoT, Identifier in the IoT, Technologies in IoT. What are wireless sensors, Sensor family, Architecture of single node sensor.	04
2	**IoT schemes and models:** Block diagram of an IoT device (node), characteristics of IoT, functional blocks of IoT, communication models. IoT levels and deployment templates. IoT enabling technologies.	08
3	**IoT stack:** M2M stack and examples, IoT stack and examples, IoT stack variants, difference between IoT and M2M. IoT Access Technologies: Physical and MAC layers, IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11 and LoRaWAN.	08
4	**Network and Communication Aspects:** Network Layer Protocols: IPv4 and IPv6, Constrained nodes and Constrained networks Optimizing IP for IoT: From 6LoWPAN to 6Lo, routing over low power and lossy networks. Application Layer Protocols: CoAP and MQTT.	05
5	**Components of IoT:** IoT platform design methodology. IoT end device computing –boards based on microcontroller and SoC. Sensor technologies, sensor data communication protocols: UART, SPI, I2C.	06
6	**IoT Case Studies:** Home automation, smart cities, environment monitoring and control, agriculture, retail sector, healthcare and lifestyle, logistics and supply chain, access control and tracking.	08

Assessment:

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Recommended Online Courses (optional):

1) Introduction To Internet Of Things
   By Prof. Sudip Misra | IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc22_cs52/preview

2) Introduction To Industry 4.0 And Industrial Internet Of Things
   By Prof. Sudip Misra | IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc22_cs52/preview

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Books Recommended:

Text books:

1) Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, universities press.
2) IOT fundamentals, David, Gonzalo, Patrick, Cisco press.
3) Data and Computer communications, william stallings, Pearson Education.
4) Data communication and networking, Behrouz A. Forouzan, McGraw Hill Education Communication Networks, Alberto Leon Garcia, McGraw Hill Education.

Reference Books:

1) Computer Networks, S. Tanenbaum, Pearson Education.
2) Computer Networking: A Top-Down Approach, J. F. Kurose and K. W. Ross, Addison Wesley.

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

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Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO7021	Department Level Optional Course – 4 Rehabilitation Engineering (Abbreviated as RE)	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.							
BMDO7021	Department Level Optional Course - IV Rehabilitation Engineering (Abbreviated as RE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDO7021	Rehabilitation Engineering	03
Course Objectives	• To Introduce the socio-legal aspects of Rehabilitation Engineering • To understand the importance of Orthotics, and Prosthesis • To introduce learners to basics of Kinetics and Kinematics. • To understand the flow properties of blood. • To understand various upper and lower limb deformities. • To understand the rehabilitation management of various deformities	
Course Outcomes	**A learner will be able to** • Understand the basic difference between Impairment, Disability and Handicap • Understand the reasons for Amputation, need of Orthosis, Prosthesis. • Understand the human joint's stability. • Understand the flow pattern of blood in normal and abnormal conditions. • Understand management of simple to complex deformities • Understand the rehabilitation management during paralytic conditions of the limb	

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Module	Contents	Hours
1	**Introduction and socio-legal aspects of rehabilitation engineering:** Medical rehabilitation, epidemiology of rehabilitation, preventive rehabilitation, impairment disability and handicap.	03
2	**Orthotics, amputation, and prosthetics, activities of daily living (ADL):** Orthotics: General principles of orthotics, biomechanics of orthotics, classification: upper & lower extremity orthotics, spinal orthotics Amputation & prosthetics: Causes of amputation, types of amputation, and levels of amputation for upper and lower extremity, preoperative and post-operative period. pre-prosthetic stage, endo & exo-skeletal prosthetics, classification of upper & lower limb prosthetics Activities of daily living: ADL grouping, Barthel's index of ADL, functional independence, measures, environmental control system, communication, ADL training.	10
3	**Mechanical principles of Kinematics and Kinetics:** Planar classification of position and motion, rotary and translatory motion, degree of freedom, kinematic chain theories of motion, levers, torque, parallel force, resolution of force, calculation of muscle and joint forces Clinical application on weight and center of gravity ,applied weights and resistance, muscle force and leverage, joint forces, clinical application on stretching versus joint mobilization.	06
4	**Flow properties of blood:** An outline of blood rheology, constitutive equation of blood based viscometric data and Casson's equation, laminar flow of blood in a tube, fluid mechanical interaction of RBCs with a solid wall, thrombus formation and dissolution, medical application of blood rheology.	06
5	**Common deformities and role of surgery in rehabilitation engineering.** Types of deformities, management of 1st and 2nd degree deformities, common deformities of lower limb, treatment for partial foot deformities, deformities of the foot, arm Deformities, torticollis	06
6	**An overview of rehabilitation of muscular dystrophy, paraplegia, and quadriplegia:** Muscular dystrophy, Duchenne muscular dystrophy, rehabilitation, facioscapulohumeral muscular dystrophy Paraplegia: Etiology, mechanism of injury, identification of level of lesion, management of active spinal cord injury, rehabilitation, gait training Quadriplegia: Mobility, training, level of injury & outcome, management.	08

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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. BRUNNSTROM'S CLINICAL KINESIOLOG, By Laura K Smith, Elizabeth Laurance Weiss; Jaypee brothers Publication
2. Mechanical properties of living tissues by Y. C. Fung

Reference Books:

1. Textbook of Rehabilitation by S. Sundar,3rd edition Jaypee publication

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.

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Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDO7022	Lasers & Fiber Optics	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.							
BMDO7022	Lasers & Fiber Optics	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDO7022	Lasers & Fibre Optics	03
Course Objectives	• To help the students to build up a detailed knowledge of the methods, fabrication, and applications of lasers & fiber optics in medical engineering. • To create a platform for students to have deeper understanding on the fundamental principles of lasers and Optical fibers in bio-photonic systems.	
Course Outcomes	Learner will be able to: • Understand types of optical source and its emission properties. • Analyze the various types of lasers and their medical applications • Familiarize the fundamentals of optical fibers. • Understand the interaction of laser with tissue along with its applications • Understand and implement the use of lasers and optical fibers for surgery and sensing.	

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Module	Contents	Hours
1.	**Introduction to optical radiation, emission & resonator:** Spontaneous and stimulated emission, Einstein's coefficients, gain coefficient, laser oscillation conditions, population inversion, three and four level systems, rate equations, optical resonators and types, modes and mode stability criteria, losses in optical resonators-quality factor.	06
2.	**Types of Lasers:** Working principle of Ruby laser, dye laser, argon ion laser, solid state lasers-fundamental and higher harmonic generation. Detailed study of semiconductor lasers, Nd: YAG laser- flash lamp pumped and diode pumped lasers, He-Ne laser, CO2 laser, excimer laser, nitrogen laser, free electron laser, Ti: Saphire laser, rare earth doped and photonic crystal fiber based lasers, soliton lasers. Chemical lasers, metal vapors lasers, medical applications of Lasers.	**07**
3.	**Fundamentals of fiber optics:** Classification of fibers- step index, graded index fiber, numerical aperture, modes in optical fiber, single mode and multimode fiber, V- parameter, evanescent modes, losses in fiber, dispersion in fiber, special fiber-polarization maintaining fiber, non-linear effects in optical fiber, fiber fabrication techniques, splicing.	07
4.	**Photobiology & bioimaging:** Interaction of light with cells and tissues, photo-processes in biopolymers, human eye and vision, optical fiber delivery system, Optical coherence tomography, Applications of bio-imaging: bio-imaging probes and fluorophores, Endoscopy.	**06**
5.	**Optical sensors:** MM and SM fibers for sensing, Lasers & LEDs suitable for sensing, PIN & APDs for fiber optic sensing. Principles of electro optic modulators bulk & integrated optic modulators, optical sensor types, advantages and disadvantages of fiber optic sensors, intensity modulated sensors, interferometric sensors, rotation sensors, bio sensors.	**07**
6.	**Laser and fiber activated therapy:** Photodynamic therapy, photo-sensitizers for photodynamic therapy, tissue engineering using light, Laser system in cardiovascular disease, gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, lasers and fibers in skin treatment.	**06**

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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. Tu Vo Dinh, Biomedical Photonics: A Handbook- CRC Press, Boca Raton, FL 2003
2. V N Prasad, Introduction to Biophotonics, Wiley-Interscience, 2003
3. Orazio Svelto, Principles of Lasers, 4thEdn, Plenum Press, 1998
4. Dakin J and Culshow B., (Ed), Optical fiber sensors, Vol I,II, III, Artech House, 1998
5. Francis T.S Yu, Shizhuo Yin (Eds), Fiber Optic Sensors, Marcel Dekker Inc., New York, 2002
6. Silfvast. W T., Laser Fundamentals, Cambridge University Press, New Delhi, 1998

Reference Books:

1. Lihong V and Hsin-IWU, Biomedical Optics-Principles, and Imaging - Wiley Interscience 1st ed. 2007
2. Mark E.Brezinski, Optical Coherence Tomography-Principles and Applications-(Academis Press 1st ed. 2006)
3. Rodney Cotterill, Biophysics –An Introduction (John Wiley Student edition)
4. Valery .V.Tuchin, A Handbook of Optical Biomedical diagnostics, SPIE press monograph vol pm 107
5. Bahaa E. A Saleh & Malvin Carl Teich, Fundamentals of Photonics, John Wiley & Sons, 1991
6. Jeff Hecht, The Laser Guide Book, McGraw Hill, 1986
7. Koechner (W alter), Solid State Laser Engineering, Springer, 1992
8. Marvin J. Weber, Handbook of Lasers, CRC Press, 2001
9. Yariv A, Optical Electronics, 4thEdn, Holt, Rinehart and Winston, 1991

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

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Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract	Tut	Total
BMDO7023	Department Optional Course – 4 Networking and Information Systems in Medicine (Abbreviated as NISM)	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme								
		Theory								
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract	Oral	Pract / Oral	Total
		Test 1	Test 2	Avg.							
BMDO7023	Department Optional Course – 4 Networking and Information Systems in Medicine (NISM)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDO7023	Networking and Information Systems in Medicine	03
Course Objectives	• To understand the fundamental component of computer Networking. • To understand the functioning and configuration of various networking devices and components. • To understand a concept about network security. • Understand various Information system used in Healthcare System • To understand the healthcare IT infrastructure Understand various IHE domains	
Course Outcomes	**Learners will be able to:** • Understand the fundamental components of computer networks and networking protocols. • Understand IP addressing, functioning and configuration of various networking devices and components • Understand concepts about network security • Understand the PACS components, architecture and PACS tele radiology • Understand HIS, RIS, integration of HIS/RIS/PACS, PACS archive storage • Understand IHE and IHE domains	

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Module	Contents	Hours
1.	PACS Components; PACS generic workflow; PACS architectures: stand-alone, client-server, and web-based; PACS and teleradiology	**06**
2.	Introduction to RIS and HIS, HIS/RIS/PACS integration; PACS archive storage: RAID; HIPPA	**06**
3.	Integrating Healthcare Enterprise: IHE workflow model, IHE domains, IHE patient information reconciliation profile, IHE radiology information integration profile	**06**
4.	Performance of network/device parameters: bandwidth, throughput, jitter, latency network technology; types of cables and connectors, crossover and straight through cables, colour coding of cables; OSI Model; TCP/IP, Addressing types (IP, MAC, Port & Specific)	**08**
5.	IP V4 addressing, subnetting, supernetting; IP V6 addressing; Detailed working of networking equipment: Hub, bridge , switch, router, modem	**07**
6.	Basic Security Concepts: Security Mechanism and security services, authentication, authorization, confidentiality, integrity, non-repudiation; Symmetric and asymmetric key cryptography, RSA algorithm	**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:

Textbooks:

1. PACS and Imaging Informatics by H.K. Huang, Second Edition, Wiley and Blackwell.
2. PACS: A Guide to the Digital Revolution by Keith J. Dreyer, Springer.
3. Data Communication and Networking by Behrouz A. Forouzan, McGraw Hill.
4. Computer Networks by A.S. Tanenbaum, Pearson Education.

Reference Books:

1. Governance of Picture Archiving and Communications Systems by Carrison K.S. Tong, Eric T.T. Wong (Medical Information Science Reference).
2. Practical Imaging Informatics, By Barton F. Branstetter, Springer.
3. PACS Fundamentals by Herman Oosterwijk.
4. Cryptography and Network Security By William Stalling, Pearsons.

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 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

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Course Code	Course Name	Teaching scheme (Contact Hours)		Credits Assigned		
ILO 7011	**Product Life Cycle Management**	Theory	Pract./Tut.	Theory	Pract./Tut.	Tota l
		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 7011	**Product Life Cycle Management**	**20**	**20**	**20**	**80**	3	**--**	**--**	**100**

Course Objectives	• To familiarize the students with the need, benefits and components of PLM • To acquaint students with Product Data Management & PLM strategies • To give insights into new product development program and guidelines for designing and developing a product • To familiarize the students with Virtual Product Development
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. • Illustrate various approaches and techniques for designing and developing products. • Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. • Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hours
1	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM	10

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2	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
3	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
4	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
5	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
6	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

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)

REFERENCES:

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

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		
ILO 7012	**Reliability Engineering**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		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 7012	**Reliability Engineering**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• To familiarize the students with various aspects of probability theory • To acquaint the students with reliability and its concepts • To introduce the students to methods of estimating the system reliability of simple and complex systems • To understand the various aspects of Maintainability, Availability and FMEA procedure
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Understand and apply the concept of Probability to engineering problems • Apply various reliability concepts to calculate different reliability parameters • Estimate the system reliability of simple and complex systems • Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hours
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	**08**
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	**08**
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	**05**

4	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	**08**
5	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	**05**
6	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

REFERENCES:

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

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		
ILO 7013	**Management Information System**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		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 7013	**Management Information System**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• The course is blend of Management and Technical field. • Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built • Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage • Identify the basic steps in systems development
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Explain how information systems Transform Business • Identify the impact information systems have on an organization • Describe IT infrastructure and its components and its current trends • Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making • Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hours
1	**Introduction To Information Systems (IS):** Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	**04**
2	**Data and Knowledge Management:** Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management **Business intelligence (BI):** Managers and Decision Making, BI for Data analysis and Presenting Results	**07**
3	**Ethical issues and Privacy:** Information Security. Threat to IS, and Security Controls	**07**
4	**Social Computing (SC):** Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	**07**
5	**Computer Networks** Wired and Wireless technology, Pervasive computing, Cloud computing model.	**06**

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6	**Information System within Organization:** Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	**08**

REFERENCES:

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

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		
ILO 7014	**Design of Experiments**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		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 7014	**Design of Experiments**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• To understand the issues and principles of Design of Experiments (DOE) • To list the guidelines for designing experiments • To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Plan data collection, to turn data into information and to make decisions that lead to appropriate action • Apply the methods taught to real life situations • Plan, analyse, and interpret the results of experiments

Module	Detailed Contents	Hours
1	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
2	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
3	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07

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4	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
5	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
6	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

REFERENCES:

1 Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001

2 D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001

3 George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley

4 W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2

5 Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss

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		
ILO 7015	**Operations Research**	Theory	Pract./Tut.	Theory	Pract./Tut.	Tota l
		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 7015	**Operations Research**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• Formulate a real-world problem as a mathematical programming model. • Understand the mathematical tools that are needed to solve optimization problems. • Use mathematical software to solve the proposed models.
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness. • Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. • Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems. • Understand the applications of integer programming and a queuing model and compute important performance measures

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Module	Detailed Contents	Hours
1	**Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
2	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
3	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
4	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
5	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
6	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

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REFERENCES:

1 Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2 Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3 Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4 Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5 Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

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		
ILO 7016	**Cyber Security and Laws**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		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 7016	**Cyber Security and Laws**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• To understand and identify different types cybercrime and cyber law • To recognized Indian IT Act 2008 and its latest amendments • To learn various types of security standards compliances
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Understand the concept of cybercrime and its effect on outside world • Interpret and apply IT law in various legal issues • Distinguish different aspects of cyber law • Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hours
1	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
2	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
3	**Tools and Methods Used in Cyberline:** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6

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4	**The Concept of Cyberspace** : E-Commerce, The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
5	**Indian IT Act:** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
6	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

REFERENCES:

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

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		
ILO 7017	**Disaster Management and Mitigation Measures**	Theory	Pract./Tut.	Theory	Pract./Tut.	Tota l
		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 7017	**Disaster Management and Mitigation Measures**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• To understand physics and various types of disaster occurring around the world • To identify extent and damaging capacity of a disaster • To study and understand the means of losses and methods to overcome /minimize it. • To understand role of individual and various organization during and after disaster • To understand application of GIS in the field of disaster management • To understand the emergency government response structures before, during and after disaster
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Get to know natural as well as manmade disaster and their extent and possible effects on the economy. • Plan of national importance structures based upon the previous history. • Get acquainted with government policies, acts and various organizational structure associated with an emergency. • Get to know the simple do's and don'ts in such extreme events and act accordingly.

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Module	Detailed Contents	Hours
1	**Introduction** *1.1* Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
2	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
3	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and coordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
4	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
5	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
6	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.	06

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	6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	

REFERENCES:

1. 'Disaster Management' by Harsh K. Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

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		
ILO 7018	**Energy Audit and Management**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		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 7018	**Energy Audit and Management**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**

Course Objectives	• To understand the importance energy security for sustainable development and the fundamentals of energy conservation. • To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management • To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • To identify and describe present state of energy security and its importance. • To identify and describe the basic principles and methodologies adopted in energy audit of a utility. • To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. • To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities • To analyze the data collected during performance evaluation and recommend energy saving measures

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Module	Detailed Contents	Hours
1	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
2	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
3	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
4	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
5	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
6	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

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REFERENCES:

1 Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2 Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3 Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4 Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5 Energy Management Principles, C.B.Smith, Pergamon Press
6 Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7 Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8 www.energymanagertraining.com
9 www.bee-india.nic.in

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		
ILO7019	**Development Engineering**	Theory	Pract./Tut.	Theory	Pract./Tut.	Total
		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 understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development • To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas • An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals • To understand the Nature and Type of Human Values relevant to Planning Institutions
Course Outcomes	**Upon successful completion of this course, the learner will be able to:** • Apply knowledge for Rural Development. • Apply knowledge for Management Issues. • Apply knowledge for Initiatives and Strategies • Develop acumen for higher education and research. • Master the art of working in group of different nature. • Develop confidence to take up rural project activities independently

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Module	Contents	Hours
1	**Introduction to Rural Development:** Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	**Post-Independence Rural Development:** Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
3	**Rural Development Initiatives in Five Year Plans:** Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06
4	**Post 73rd Amendment Scenario:** 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10
6	**Ethics:** Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	04

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References:

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V., Conflicting Rationalities: -Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

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			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML701	Biomedical Instrumentation- -III Lab (Abbreviated as BMI-III 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.						
BML701	Biomedical Instrumentation- -III Lab (BMI-III Lab)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML701	Biomedical Instrumentation- -III	01
Course Objectives	• To understand the basic principles and working of life Saving Equipment. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcomes	**Learner will be able to…** • Design and implement basic Pacemaker circuits. • Design and implement basic oscillator circuits for Surgical Diathermy. • Demonstrate the knowledge of application techniques of physiotherapy machines. • Demonstrate the knowledge of application technique of oximeter	

Syllabus: Same as that of (Course Code) Biomedical Instrumentation- -III (BMI-III)

List of Experiments: (Any Seven)

1. Implementation and testing of basic circuit of pacemaker.
2. Implementation of NAND Gate Oscillator in Surgical Diathermy.
3. Implementation of RLC Over damped system.
4. Implementation of OT lights.
5. Demonstration of Defibrillator.
6. Demonstration of Pacemaker.
7. Demonstration of Surgical Diathermy
8. Demonstration of Ultrasonic Diathermy
9. Demonstration of Nerve and Muscle Stimulator
10. Demonstration of Oximeter.
11. Industry / Hospital visits may be conducted.

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

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

Assessment:

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) : 5 Marks
Presentation : 5 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

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

Reference books:

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

Oral examination will be based on entire syllabus.

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Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML702	Machine Learning Laboratory (Abbreviated as ML Lab)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Dura tion (hrs)	Term work	Pract	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BML702	Machine Learning Lab (ML Lab)	--	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BMC702	Machine Learning	03
Course Objectives	• To build a strong base in artificial intelligence through algorithm development. • To develop competency in logical thinking, computer programming and knowledge application. • To train and motivate for higher education and research in order to make contribution to state of the art health care for all	
Course Outcomes	**Learner will be able to…** • Understand the fundamental techniques and applications in neural networks, deep learning and machine learning • Understand supervised and unsupervised learning, back propagation and gradient descent algorithms • Understand and implement efficient computational techniques using neural networks, deep learning and machine learning • Design and implementation of neural network models with deep learning and machine learning will be strong base for designing artificial intelligent systems	

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Syllabus: Same as that of (BMC702) Machine Learning (ML)

List of Experiments: (Any Seven)

1 Implement the activation functions used in the neural network
2 Implement ANDNOT and XOR function using McCulloch-Pitts neural net
3 Implementation of learning rules for neural network
4 Implementation of backpropagation with gradient descent algorithm neural network
5 Design and implement the neural network model for estimation problem.
6 Design and implement the neural network model for classification problem
7 Optimize the neural network model for estimation problem.
8 Optimize the neural network model for classification problem.
9 Design and implement the neural network model for estimation problem with deep learning
10 Design and implement the neural network model for estimation problem with deep learning

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 : 05 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Text books

1. Introduction to Machine Learning, 3rd edition, Ethem Alpaydin, PHI Learning Private Limited, New Delhi, 2015
2. Deep Learning by Josh Patterson and Adam Gibson, O'Reilly Media, Inc., Gravenstein Highway North, Sebastopol CA, 2017
3. Neural Networks and Learning Machines Third Edition, Simon Haykin, Pearson, Prentice Hall, 2009

Reference books

1. Machine learning in Action, Peter Harrington, dreamtech Press, New Delhi, 2012
2. Machine learning, Tom M, Mitchell, Mc Graw Hill Education(India) Private Limited New Delhi, 2013

Practical examination will be based on experiments and related topics in the laboratory sessions.

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Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDL7011	Department Level Optional Course – 3 Biological Modeling and Simulation Lab (BMS 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.						
BMDL7011	Department Level Optional Course – 3 Biological Modeling and Simulation (BMS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDL7011	Biological Modelling and Simulation Lab	01
Course Objective	● To understand basic approach of modeling for designing biological model. ● To simulate physiological processes for better understanding. ● To develop competency in terms of logical thinking, programming and application skills ● To train and motivate students for pursuing higher education and research for developing cutting edge technologies.	
Course Outcome	Learner will be able to: ● Apply concept of physiological modelling to model thermometer system. ● Virtually understand biophysical laws for calculation of membrane potential under different equilibrium conditions and develop simulation programs for understanding neuronal functions. ● Simulate mathematical model for the eye movement ● Electrically simulate model of thermoregulatory system ● Understand the usage of, and the assumptions behind biological models	

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List of Laboratory Experiments (Any Seven)

1. Simulations thermometer system using MATLAB
2. Simulation of Nernst/Goldman Equation using MATLAB((**Two practicals**))
3. Simulation of eye movement using MATLAB
4. Simulation using HHSim **(Two practicals)**
5. Simulation using Neurons in Action **(Two practicals)**
6. Developing a model of a neuron using NEURON
7. Electrical simulation of thermoregulatory model

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

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) :

10 Marks Laboratory work (Journal) :

10 Marks

Attendance : 5 Marks

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

Books Recommended:

Text Books:

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Oral examination will be based on entire syllabus.

DRAFT

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDL7012	Bioinformatics Lab (Abbreviated as BI 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.						
BMDL7012	Bioinformatics Lab (BI Lab)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDL7012	Bioinformatics Lab	01
Course Objectives	• The course introduces the students to the field of Bioinformatics. • To make students aware about the methods to characterise and manage the different types of biological data. • To introduce students to the basics of sequence alignment and analysis.	
Course Outcomes	**Learner will be able to** • Get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis. • Apply knowledge of basic principles of mathematics and statistics. • Apply existing software effectively to extract information from large databases and to use this information in computer modelling • Apply problem-solving skills to multivariate methods in bioinformatics Search and apply bioinformatics tools to analyse and interpret biological data	

Syllabus: Same as that of BMDO7012 Bioinformatics

List of Tutorials: (any seven Tutorials based on following topics)

1. Steps in DNA sequencing
2. Different methods of DNA sequencing
3. Discovery of Gene Sequence.
4. Types of Proteomics
5. Mendel's postulates and laws of inheritance
6. Steps of dynamic programming
7. Classification of biological databases
8. Steps in Hypothesis Testing
9. Types of statistical models
10. Important Algorithms in Bioinformatics

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

A power point presentation on any of the topics in syllabus should be carried out.

Assessment:

Term Work:

Term work shall consist of minimum 7 tutorials.

The distribution of marks for term work shall be as follows:

Laboratory work (Tutorials) : 10 Marks
Presentation : 10 Marks
Attendance : 5 Marks

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

Books Recommended:

Text books:

1. Basics of Bioinformatics, Rui Jiang, Xuegong Zhang, Michael Q. Zhang, Springer, E-book.
2. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 2002, First Edition.

Reference Books:

1. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

Oral examination will be based on entire syllabus.

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Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDL7013	IOT Based Systems 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.						
BMDL7013	IOT Based Systems Lab	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDL7013	IOT Based Systems Lab	01
Course Objectives	• Learn the concepts of IOT • Identify different technologies and schemes • Learn different applications in IOT • Learn different protocols used in IOT • Learn how to analyze the data in IOT	
• Course Outcomes	**Learner will be able to** • Apply the concepts of IOT • Identify and select different technologies and scheme for IOT applications • Apply IOT to different applications • Analyze and evaluate protocols used in IOT systems • Analyze dataflow in IOT systems	

Syllabus: Same as that of (Course Code) Bioinformatics

List of Experiments: (any seven Experiments based on following list)

1) To demonstrate I/O operations, interrupts, ADC and other onboard features using any one hardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).
2) To demonstrate interfacing various sensors and storing data on-board [and on-board processing of data] using any one hardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).
3) To demonstrate interfacing various sensors and communicating data using Internet using any one hardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).

4) To demonstrate CoAP protocol (client – server model) with SOC platform as server.
5) To demonstrate CoAP protocol (client – server model) with SOC platform as client.
6) To demonstrate MQTT broker (publish - subscribe model) with SOC platform as broker.
7) To demonstrate MQTT broker (publish - subscribe model) with SOC platform as publisher.
8) To demonstrate the use of cloud storage.
9) To demonstrate the use/role of cloud computing.

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

Assessment:

Term Work:

Term work shall consist of minimum 7 tutorials.
The distribution of marks for term work shall be as follows:
Laboratory work (Tutorials) : 10 Marks
Presentation : 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:

Books Recommended:

Text books:

1. Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, universities press.
2. IOT fundamentals, David, Gonzalo, Patrick, Cisco press.
3. Data and Computer communications, william stallings, Pearson Education.
4. Data communication and networking, Behrouz A. Forouzan, McGraw Hill Education
Communication Networks, Alberto Leon Garcia, McGraw Hill Education.

Reference Books:

1. Computer Networks, S. Tanenbaum, Pearson Education.
2. Computer Networking: A Top-Down Approach, J. F. Kurose and K. W. Ross, Addison Wesley.

Oral examination will be based on entire syllabus.

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Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMP701	Major Project - I	--	06	--	--	03	--	03

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMP 701	Major Project - I	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMP701	Major Project-I	03
Course objective	• To apply the knowledge gained during Curriculum to develop and design problem statement. • Conduct literature survey. • Design Circuit/ Flow chart of the statement. • Documentation and project report writing.	
Course Outcome	**Learner will be able to** • Review literature to define problem statement • Apply knowledge of the engineering fundamentals acquired during the curriculum and beyond • Develop and create design using appropriate design methodologies considering the various health, society and environmental needs. • Write problem statement, Design concept in prescribed format. • Learn the behavioral science by working in a group.	

Project Guidelines:

1. Learner is allotted 6 hrs per week for the project work
2. Learners should carry out literature survey /visit industry / analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor.
3. Group of maximum four students will be completing a comprehensive project work.
4. Learners should use multiple literatures and understand the problem.
5. Learners should attempt solution to the problem by experimental/simulation methods.
6. The solution to be validated with proper justification and compile the report in standard format
7. Learner may use this opportunity to learn different computational techniques as well as some model development.

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Faculty Load:

1. In semester VII – 1/2 (half) period of 1/2 hour per week per project group
2. Each faculty is permitted to take (guide) maximum 4 (Four) project groups

Assessment:

Term Work:

Term Work should be examined by approved internal faculty appointed by the head of the institute based on the 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- I

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

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