UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Mechanical Engineering

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Final YearB.E. in Mechanical 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	~~P.G.~~ **/ U.G./** ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ **/ Semester** (Strike out which is not applicable)
8	Status	~~New~~ **/ Revised** (Strike out which is not applicable)
9	To be implemented 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

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 171, 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.

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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.

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Faculty of Science and Technology
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Preface

When the entire world is discussing about 'Industry 4.0', we are at the crossroads. There are so many expectations from the graduating engineers, who shall be the major contributors to ecosystem for development of the Nation. Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by several faculty members and Industry experts. The Program Educational Objectives proposed for the undergraduate program in Mechanical Engineering are listed below:

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders.We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar : Chairman
Dr. S. M. Khot : Member
Dr. V. M. Phalle : Member
Dr. Siddappa S.Bhusnoor : Member
Dr. S.S. Pawar : Member
Dr. Sanjay U. Bokade : Member
Dr. Dhanraj Tambuskar : Member

Program Structure for Final Year Engineering
Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2021-2022)
Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
MEC701	Design of Mechanical System	4	--	4	--	4
MEC702	Logistics and Supply Chain Management	3	--	3		3
MEDLO703X	Department Level Optional Course – 3	3	--	3	--	3
MEDLO704X	Department Level Optional Course – 4	3	--	3	--	3
ILO701X	Institute Level Optional Course – I*	3	--	3	--	3
MEL701	Design of Mechanical System	--	2	--	1	1
MEL702	Maintenance Engineering	--	2	--	1	1
MEL703	Industrial Skills	--	2	--	1	1
MEP701	Major Project I	--	6#	--	3	3
Total		**16**	**12**	**16**	**6**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test2	Avg					
MEC701	Design of Mechanical System	20	20	20	80	3	--	--	100
MEC702	Logistics and Supply Chain Management	20	20	20	80	3	--	--	100
MEDLO703X	Department Level Optional Course – 3	20	20	20	80	3	--	--	100
MEDLO704X	Department Level Optional Course – 4	20	20	20	80	3	--	--	100
ILO701X	Institute Level Optional Course – I*	20	20	20	80	3	--	--	100
MEL701	Design of Mechanical System	--	--	--	--	--	25	25	50
MEL702	Maintenance Engineering	--	--	--	--	--	25	25	50
MEL703	Industrial Skills	--	--	--	--	--	25	25	50
MEP701	Major Project I	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	--	**125**	**75**	**700**

# indicates work load of Learner (Not Faculty), for Major Project
* Common with all branches

Department Optional Courses

Course Code	Sem. VII: Department Optional Course- 3		Course Code	Sem. VII: Department Optional Course - 4
MEDLO7031	Automotive Power Systems		MEDLO7041	Machinery Diagnostics
MEDLO7032	Renewable Energy Systems		MEDLO7042	Vibration Controls
MEDLO7033	Vehicle Systems		MEDLO7043	Advanced Vibration

Institute Optional Courses

Course Code	Institute Optional Course-I #
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Common with all branches

Course Code	Course Name	Credits
MEC701	**Design of Mechanical System**	**04**

Objectives:

1. To familiarize with the concept of system and methodology of system design
2. 2. To study system design of various systems such as Gear box, snatch block, belt conveyors, I. C. engine system and pumps

Outcomes: Learner will be able to…

1. Apply the concept of system design.
2. Select appropriate gears for power transmission on the basis of given load and speed
3. Design material handling systems such as hoisting mechanism of EOT crane,
4. Design belt conveyor systems
5. Design engine components such as cylinder, piston, connecting rod and crankshaft
6. Design pumps for the given applications

Module	Contents	Hours
1.	Methodology & Morphology of design, Optimum design, system concepts in design.	**03**
2.	**Design of Transmission Gear Box:**	**08**
	Single stage andTwo stage Gear box with fixed ratio consisting of Design of spur, helical, bevel and worm and wormwheel gear pairs, Gear box housing layout and housing design.	
3.	**Design of Hoisting Mechanism:**	**08**
	Design of Snatch Block Assembly including Rope Selection, Sheave, Hook, Bearing for hook, cross piece, Axle for sheave and shackle plate, Design of rope drum, selection motor with transmission system.	
4.	**Design of Belt Conveyors :**	
	Power requirement, selection of belt, design of tension take up unit, idler pulley	**04**
5.	**Engine Design (Petrol and Diesel):**	
	Design of cylinder, Piston with pin and rings, connecting rod & crank shaft with bearings	**08**
6.	**Design of Pump:**	**08**
	5.1 Design of main components of gear pump.	
	1 Motor selection	
	2 Gear design	
	3 Shaft design and bearing selection	
	4 Casing and bolt design	
	5 Sizing of design of suction and delivery pipe	
	5.2 Design of main components of Centrifugal Pump:	
	1 Motor selection	

	2 Suction and Delivery pipe	
	3 Design of Impeller, Impeller shaft	
	4 Design of Volute Casing	

Sr. no. **Text/Reference Books:-**

1 "Machine Design Exercises", S.N.Trikha - New Delhi Khanna Publisher 1978.

2 "Mechanical Engineering Design", Shigley J E and Mischke C R,11th Edition 2019, McGraw Hill, ISBN: 9788184956207.

3 "Mechanical design analysis", MF Spotts, 3rd Edition, Prentice Hall Inc.

4 "Design of Machine Elements", Bhandari VB,5th Edition 2020, TMH,ISBN: 9789390177479

5 "Machine Design", Black PH and O Eugene Adams, 3rd Edition, McGraw Hill ISBN 10: 0070055246

6 "Design Data", P.S.G. College of Technology, Coimbatore. ISBN: 978-8192735504

7 "Engineering Design", Dieter G E, McGraw Hill Inc, ISBN: 9781260113297

8 "Mechanical System Design", SP Patil, 2nd Edition., JAICO Publishing House ISBN: 978-8179923153

9 "Material Handling Equipment", Rudenko,2nd Edition, M.I.R. publishers, Moscow

10 "Machine Design-An Integrated Approach", Robert L. Norton,6th Edition, Pearson Education, ISBN: 9780135184233

11 "Material Handling Equipments", N. Rudenko, Peace Publication

12 "Material Handling Equipments", Alexandrov,5th Edition, Mir Publication ISBN: 9780714717456

13 Machine Desgin", Reshetov, Mir Publication 1978.

14 "Machine Design", R.C.Patel, Pandya, Sikh, Vol -I & II,12th Edition, C. Jamnadas& Co.

15 "Design of Machine Elements", 4th Edition, V. M. Faires, ISBN: 978-0023359507

16 "Pumps: Theory, Design and Applications", G K Sahu, New Age International 2000 ISBN: 9788122412246

17 "Gear Design Handbook", GitinMaitra, 2nd Edition, ISBN: 978-0074602379

18 "Design Data Book- Design of engine parts",Khandare S.S & Kale A.V, 2nd Edition, ISBN: 978-9352654260

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc22_me62 - Gear And Gear Unit Design: Theory and Practice, IIT Kharagpur
2. https://nptel.ac.in/courses/112/106/112106137/ - Machine Design-II, IIT Madras

Course Code	Course Name	Credits
MEC702	**Logistics and Supply Chain Management**	**03**

Objectives:

1. To understand the fundamentals of supply chain management and Logistics
2. To develop an understanding related to Supply Chain Performance and related aspects
3. To understand Inventory management in supply chain
4. To learn tools and techniques used in logistics, transportation, warehousing and outsourcing decisions.
5. To develop critical understanding towards digitization in supply chain management and sustainability
6. To develop analytical and critical understanding for planning and designing supply chain network.

Outcomes: Upon successful completion of this course, the learner will be able to

1. Demonstrate a sound understanding of Logistics and Supply Chain Management concepts and their role in today's business environment.
2. Identify the drivers of supply chain performance and risks in supply chain management.
3. Apply various techniques of inventory management and rank the items using inventory management technique
4. Apply various strategies and techniques to minimize overall logistics cost
5. Understand the role of digitization in supply chain management leading to sustainability
6. Apply various mathematical models/tools to design the supply chain network

Module	Contents	Hours
1.	**Introduction:** Objectives of a Supply Chain Management, Stages of Supply chain, Value Chain Process, Cycle view of Supply Chain Process, Key issues in SCM, logistics & SCM, Supply Chain Drivers /decisions and obstacles, Supply chain strategies, strategic fit, Best practices in SCM, Obstacles of streamlined SCM. Supplier Selection, Supplier quality audits, Contract management, Non-Disclosure Agreement (NDA), Make & Buy Decision while in-out sourcing	**05**
2.	**Supply Chain Performance:** Bullwhip effect and reduction, Performance measurement: Dimension, Tools of performance measurement, SCOR Model. Demand chain management, Global Supply chain- Challenges in establishing Global Supply Chain, Factors that influences designing Global Supply Chain Network. Supply Chain Risk Management (Risks involved in supply chain which includes – Supplier Financial Risk, Performance Risk, Compliance Risk, Country specific Risk, Cyber Security. Supplier performance measurement – (Delivery & Quality performance, schedule adherence, Goods receipt compliance etc), Supplier Capacity Analysis, Supplier Score card.	**09**

3.	**Inventory management:** Definition of Inventory, Inventory types & functions; EOQ Model and Buffer Stock, Assumptions, Instantaneous Replenishment case, Demand and production rate are different, when backorders are allowed, Buffer Stock and ROL. Replenishment systems (Q and P system) Inventory Control- ABC Analysis, Numerical problems on ABC analysis,VED Analysis	**06**
4.	**Logistics Management and outsourcing:** Evolution, Objectives, Components and Functions of Logistics Management, Distribution related Issues and Challenges; Gaining competitive advantage through Logistics Management, Transportation- Functions, Costs, and Mode; Network and Decision, Containerization, Cross docking. Warehousing: Concept and types, Warehousing strategy, Warehouse facility location & network design Part Packaging, Use of Returnable pallets, ASN – Advance Shipment Notification. Reverse logistics: Outsourcing - Nature and concept, Strategic decision to Outsourcing, Third party logistics(3PL), Fourth party logistics(4PL), Cold chain operations in Supply chain.	**08**
5.	**Digitization in supply chain Management and Sustainability:** IT in supply chain - Role of IT in a supply chain, The supply chain IT framework, Application of Bar coding, Significance of SAP/RFID, The future of IT in the supply chain, Supply chain IT in practice, TMS (Transport Management System), WMS (Warehouse Management System) Green supply chain management, Supply Chain sustainability, Supply Chain sustainability index measurement with case studies. Social aspects of supply chain (CSR), Environment aspects of supply chain (CO_2 emission), resource utilization, recycling.	**04**
6.	**Supply Chain Network Design:** Factors influencing distribution network design, Supply chain resilience, Design options for distribution network, Introduction to mathematical modelling, considerations in modelling SCM systems, Overview of the models, Models on transportation, Transportation problem, Vehicle routing problem, Travelling salesman problem, Capacitated transhipment problem, shortest path problem. Value Stream Mapping (VSM), Order Fulfillment Process Flow, understanding the terms related to Supply chain- Lead Time, Takt Time ,Minimum Order Quantity (MOQ), Manufacturing Critical Path Time (MCT)	**07**

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**.

Text/Reference Books: -

1. R.P. Mohanty, S.G. Deshmukh, "Essentials of Supply Chain management", 1st Edition 2004, Jaico Publishing House.
2. S.K. Bhattacharya, "Logistics Management", 3rd Edition, Pearson Publication ISBN: 9788131768624
3. Sunil Chopra, P. Meindl, "Supply Chain Management", 6th Edition 2016, Pearson Education Asia.
4. Martin Christopher, "Logistics and Supply Chain Management",4th Edition 2010, Pitman Publishing.
5. Bowon Kim, "Supply Chain Management in Mastering Business in Asia", Edition 2005, John Wiley & sons (Asia) Pvt Ltd, ISBN: 978-0470821404
6. Michael Hugos, "Essentials of Supply Chain Management", 4th Edition 2018, John Wiley and Sons, ISBN: 9781119461104
7. Rahul V Altekar, "Supply Chain Management: Concepts and cases", Edition 2009, PHI, ISBN: 9788120328594.
8. D. Simchi-Levi, P. Kaminsky, E. Simchi-Levi, and Ravi Shankar, "Designing and Managing the Supply Chain concepts, Strategies and Case studies", 3rd Edition, Tata McGraw Hill, New Delhi, 2008.

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc22_mg74/preview
2. https://onlinecourses.swayam2.ac.in/cec22_mg22/preview

Course Code	Course Name	Credits
MEDLO7031	**Automotive Power Systems**	**03**

Objectives:

1. To familiarize with the working of S.I. and C.I. engines and its important systems
2. To provide insight into the harmful effects of engine pollutants and its control
3. To familiarise with the latest technological developments in engine technology

Outcomes: Learner will be able to…

1. Demonstrate the working of Fuel supply and ignition system of I.C. engines
2. Illustrate the working of lubrication, cooling and supercharging systems.
3. Comprehend the different technological advances in engines and alternate fuels
4. Identify and describe the history and different EV/HEV drivetrain topologies
5. Compare and evaluate various energy sources and energy storage components for EV and HEV application.
6. Comprehend EV and HEV working through Case studies.

Module	Contents	Hours
1	Constructional Features of I.C. Engines. Parts of I.C. engine and their materials. Fuel Supply System : Fuel-Air ratio, Fuel air mixture requirement, Conventional fuels used in IC engines, Fuel injection system in SI and CI engine and MPFI Engine. Ignition System : Battery Ignition System, Magneto Ignition System, Functions and working of ignition coil, spark plug, contact breaker point, Requirements and working of Ignition advance mechanisms; mechanical and vacuum, Electronic Ignition Systems; Capacitor Discharge Ignition System, Transistorized Coil Assisted Ignition System, Transistor Ignition system with contactless breaker	**08**
2	Lubrication System : Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems Cooling System : Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling Supercharging/Turbocharging : Objectives, Limitations, Methods and Types, Different arrangements of turbochargers and superchargers (No Numericals)	**06**

3	Engine Exhaust Emission and its control Constituents of exhaust emission at its harmful effect on environment and human health, Formation of NOx, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms. Alternative Fuels Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas – Biodiesel-Biogas - Producer Gas - Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. Basics of Electronic Engine Controls: Electronic Control module (ECM), Inputs required and output signals from ECM, Sensors: Throttle Position, Inlet Air Temperature, Coolant Temperature, Crankshaft Position, Camshaft Position, Mass Air flow and Exhaust Gas Oxygen sensors, their construction and importance in ECM. Electronic Spark control, Air Management system, Idle speed control	**08**
4	Introduction to Hybrid and Electric Vehicles: History of Electric Vehicles (EV) and Hybrid electric vehicles (HEV),need and importance of EV and HEV, Indian and Global Scenario of EV and HEV. Drivetrain topologies:Electric traction and hybrid traction system,Electric drive topologies,hybrid drivetrain topologies. Power energy supply requirement for EV/HEV applications.	**06**
5	Electric Drives and controller: Electric system components for EV/HEV, AC and DC motor drives, RPM and Torque calculation of motor, Motor Controllers,	**05**
6	Energy Sources for EV/HEVs: Requirement of energy supplies and storage in EV/HEV,Types of batteries(Lead Acid/Li-ion/NiMH) and its working,battery specifications, Battery Management system; Fuel cells,flywheels and ultra-capacitors as energy sources for EV/HEV,Concept of Hybridisation for different energy sources. Energy Management Strategies: EV/HEV energy management strategies,classification and comparison of various energy management strategies Battery charging: Type of battery charging systems, Selection and Sizing of charging station, Components of charging station.On board Charger. Payback period of EV and HEV Electric Vehicles charging station Type of Charging station, Selection and Sizing of charging station, Components of charging station, Single line diagram of charging station, Payback period of EV and HEV Case Study:Toyota Prius,Honda Insight,Tata Nexon EV	**06**

TextBooks:-

1. A Course on Internal Combustion Engine,Mathur and Sharma,Dhanpat Rai & Sons,New Delhi,2001.
2. Internal Combustion Engine,V.Ganesan,Mc Graw Hill,1995
3. Internal Combustion Engine, Domkundwar & Domkundwar,Dhanpat Rai & Sons,New Delhi,2013.
4. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, CRC Press,2005

Reference Books:-

1. Fundamental of Internal Combustion Engines,Gill and Smith,Oxford & IBH Publishing Company Pvt.ltd,2007
2. Internal Combustion Engine Fundamentals,Heywood,McGraw Hill,1988
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press,2003
4. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley,2003

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/107106088
2. https://nptel.ac.in/courses/112103262
3. https://nptel.ac.in/courses/108102121
4. https://nptel.ac.in/courses/108106170

Course Code	Course Name	Credits
MEDLO7032	**Renewable Energy Sources**	**03**

Objectives:

1. To study working principles of various renewable energy sources and their utilities.
2. To study design and installation criteria of various equipment's to convert the renewable energy into useful energy.
3. To study economics of harnessing energy from renewable energy sources.

Outcomes: Learner will be able to…

1. Describe the need for renewable energy and its potential for the development of a sustainable environment.
2. Analyze different solar collectors using geometrical parameters and photovoltaics for generation of solar energy.
3. Identify and analyze various wind turbine energy harnessment techniques.
4. Design biogas plant for harnessing energy from organic waste.
5. Describe significance of hydrogen energy to fulfill present and future energy needs.
6. Describe the operating principle of geothermal energy and ocean energy and their role in sustainable development.

Module	Contents	Hours
1	**1.1: Introduction to Renewable Energy Sources and Solar Radiation**: Global and National current energy scenarios, Prospects of renewable energy sources and renewable energies role in developing sustainable model. **1.2:** Solar radiation terms, solar geometry, earth sun angles, attenuation and measurement of solar radiation on horizontal and inclined surfaces, methods of solar radiation estimation.	**05**
2	**Solar Thermal Energy:** **2.1:** Introduction and working principle of flat plate collectors, thermal performance analysis of flat plate collectors, concentrating collectors, Installation and maintenance criteria of solar thermal systems. **2.2:** Solar thermal devices- Solar air heater and different types of solar air heaters, solar water heater and different types of solar water heaters, solar	**07**

	dryers, solar pond, solar distillation, solar still, solar cooker. **2.3:** Solar space heating & cooling, solar refrigerator, solar thermal energy storage systems. Case Study: Solar thermal power plant working operation.	
3	**Solar Photovoltaic Energy:** **3.1:** Introduction and working principle of a solar PV systems, types of solar PV cells, solar tracking systems, controls and measurement methods of solar PV systems. **3.2:** Methods to improve the efficiency of PV cells, parameters which affect the efficiency and life cycle of PV cells. Case Study: Installation of 1 kW of solar PV plant.	**07**
4	**Wind Energy**: **4.1:** Basic components and working principle of wind energy conversion systems, wind data and site selection considerations, various types of wind energy conversion systems, constructional features of horizontal and vertical axis wind machines, performance analysis of horizontal and vertical axis wind machines. **4.2:** Estimation of power output- betz limits, Environmental impacts of wind energy.	**06**
5	**5.1: Energy from Biomass**: Introduction of bioenergy, conversion technologies, types of biogas generation plants, design and construction details of biogas plant (KVIC), site selection, digester design consideration, filling a digester for starting, maintaining biogas production, utilization of biogas. **5.2: Hydrogen Energy: I**ntroduction and application, General introduction to infrastructure requirement for hydrogen production,	**07**

	storage, dispensing & utilization. Principles of fuel cells, types of fuel cells, power generation by fuel cells, applications of fuel cells.	
6	**6.1: Geothermal Energy**: Introduction to geothermal technologies and methods of extracting geothermal energy, prospects of geothermal energy in India. **6.2: Energy from the ocean**: Wave energy characteristics and wave energy conversion devices, tide energy conversion devices, Ocean Thermal Energy Conversion (OTEC) systems. **6.3: Energy management and economics:** Energy conservation, energy security, energy economics, energy audit- definition, need, types of energy audit, Energy management (audit) approach-understanding energy costs, Energy conservation in Buildings: Energy Conservation Building Codes (ECBC): Green Building, LEED rating.	**07**

Visit to wind farm/solar plant/biogas plant.

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.

Reference Books:

1. "Non-conventional Energy Sources", G.D. Rai, 6th Edition, Khanna Publishers, ISBN: 978-81-7409-073-7
2. "Renewable Energy: Power for a Sustainable Future", Edited by Godfrey Boyle, 3rd Edition 2012, Oxford University Press, ISBN: 978-0199681273
3. "Solar Energy: Principles of Thermal Collection and Storage", SP Sukhatme and J K Nayak, 4th Edition, Tata Mcgraw Hill Publishing Co. Ltd.
4. "Solar Energy: Fundamentals and Applications", H.P. Garg& Jai Prakash, First Revised Edition, Tata McGraw-Hill Education.
5. "Wind Power Technology", Joshua Earnest, 2nd Edition, PHI Learning, 2015.
6. "Solar Engineering of Thermal Processes", John A . Duffie and William A Bechman, 4th Edition, Wiley Publications.
7. "Renewable Energy Sources", J W Twidell& Anthony D. Weir, 3rd Edition 2015,ELBS Pub, ISBN: : 978-1-315-76641-6
8. "Energy Conversion Systems", Rakosh Das Begamudre, New Age International (P) Ltd., Publishers, New Delhi, 2007, ISBN: 9788122412666
9. "Solar Photovoltaics: Fundamentals, Technologies and Applications", C S Solanki, 3rd Edition, PHI Learning.
10. "Biomass Regenerable Energy", D. D. Hall and R. P. Overend, John Wiley, New York, ISBN:047190919X
11. "Wind and Solar Power Systems", Mukund R Patel, 2nd Revised Edition, CRC Press, ISBN: 9780429114960
12. "Wind Energy Explained: Theory, Design and Application", J F Manwell, J.C. McGowan, A.L.Rogers,2nd Edition 2009, John Wiley and Sons.

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/103103206
2. https://nptel.ac.in/courses/103107157
3. https://nptel.ac.in/courses/115105127

Course Code	Course Name	Credits
MEDLO7041	**Machinery Diagnostics**	**03**

Objectives :

1. To study basic concepts of Vibration Monitoring.
2. To study different Vibration Measuring Instruments.
3. To study fault detection in Machines using vibration spectrum.

Outcomes: Learner will be able to…

1. Relate basic concepts of Machinery Diagnostic.
2. Describe the working of Vibration Measuring Instruments.
3. Apply different Signal Processing Techniques in Vibration Measurement.
4. Identify common faults in Machinery using Vibration Spectrum.
5. Interpret the Vibration Signals for Monitoring and Prognosis.

Module	Contents	Hours
1	**1.1 Basics of Vibration** Periodic and random motion, Spectral Amplitude Scaling: RMS, Peak and Peak-to-Peak Conversion and Selection, Time and frequency domain analysis, Phase analysis, Orbit analysis, Understanding signal pattern, Importance of speed in accurate diagnosis, Importance of side bands in frequency spectrums. **1.2 Introduction to Vibration based Condition Monitoring** Maintenance Principles, Vibration based fault Prognosis, Goal of Vibration Monitoring, Steps in Vibration Monitoring, Benefits of Vibration based condition monitoring.	**07**
2	**Vibration Measurement** Vibration measuring instruments: displacement, velocity, acceleration; Force measurement, Laser based measurements: laser vibrometer Sensor Selection Criteria , Sensor – Mounting Locations and Techniques	**07**
3	**Data Acquisition & Signal Processing** Classification of signals, Signal analysis, Fast Fourier Transform (FFT), Essential Settings in Data Acquisition System (Plot Formats, Frequency Span and Frequency Resolution, Average Types and Number of Averages, Windowing, Spectrum Scaling), Signal conditioning	**07**
4	**Machinery Fault Diagnosis I** Natural frequency and resonance tests (Practical approach), Time and Frequency domain analysis to identify unbalance, bent shaft, Misalignment, Soft foot conditions, Mechanical looseness	**06**
5	**Machinery Fault Diagnosis II**	**06**

	Rolling element bearing and Journal Bearing fault diagnosis, Faults related to Gearbox, vane defects in pumps, Fault in Fans and Blowers.	
6	**Applications of Condition Monitoring** Case studies related Balancing Problems in Turbines, Condition Monitoring in Sugar mills, Health Monitoring of Journal Bearing, Condition Monitoring of Industrial Pumps. (Aspects to be covered : Selection of sensors, recommended location of sensor, direction of measurement, selection of plot type, Data validation and Identification of Faults)	**06**

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**.

Text/Reference Books:

1. R.B. Randall, "Vibration-based Condition Monitoring", Wiley2021, ISBN: 978-1-119-47755-6
2. A.R. Mohanty, "Machine Condition Monitoring: Principles and Practices", CRC Press 2017, ISBN: 9781138748255
3. R.A. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring",1st Edition, Chapman and Hall, ISBN: 978-94-009-5723-7
4. J.S. Rao, "Vibratory Condition Monitoring of Machine", Narosa Publishing House.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112105232 – Machinery Fault Diagnosis and Signal Processing, IIT, Kharagpur

Course Code	Course Name	Credits
MEDLO7042	**Vibration Controls**	**03**

Objectives :

1. To study Vibration Absorbers.
2. To study Vibration Isolators.
3. To study Vibration Control.

Outcomes: Learner will be able to…

1. Apply basic concepts of Vibration Isolation and Damping.
2. Identify suitable Vibration Absorber
3. Identify suitable Vibration Isolator
4. Apply suitable method to Control the vibrations to the acceptable level.

Module	Contents	Hours
1	**1.1 Introduction:** Vibration reduction at source, factors affecting vibration level, isolation of the source, methods of vibration control, dynamic properties and selection of materials	**05**
2	**2.1 Dynamic vibration absorbers:** Dynamic vibration neutralizers, self-tuned pendulum neutralizer, optimum design of damped absorbers, absorber with ideal spring and viscous dashpot, gyroscopic vibration absorbers, impact absorbers, absorbers attached to continuous systems	**08**
3	**3.1 Vibration isolation of single degree of freedom systems:** Isolators with complex stiffness, Isolators with Coulomb damping, Three-element isolators, Two-stage isolators, Pneumatic suspension, Concept of negative stiffness in vibration isolation	**08**
4.	**4.1 Active vibration control:** Classification and modelling, actuators and sensors for active vibration control, Active vibration absorption and damping, classical control, optimal control, Piezoelectric transducers for active vibration control **4.2 Semi-active vibration control:** Introduction, Magneto-rheological fluids, MR models and devices, semi-active suspension, narrowband disturbance	**08**
5	**5.1 Active, semi-active, and adaptive dynamic vibration absorbers:** Active tuned vibration absorber, active mass damper, adaptive vibration	**05**

	absorber, semi-active tuned vibration absorber	
6	**6.1 Active and semi-active vibration isolation:** Active single-axis base isolation, active force isolation system, isolator based on piezoelectric stack actuator, semi-active isolation, Adaptive-passive vibration isolation, active control of vehicle suspensions	**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)

End Semester Examination:

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

5. Question paper will comprise of total **six questions, each carrying 20 marks.**
6. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
7. **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)
8. Only **Four questions need to be solved**.

Text/Reference Books:

1. A.K. Mallik and A. Chatterjee, "Principles of Active and Passive Vibration Control", East-West-Press 2014, ISBN: 9788176710985
2. A. Preumont, "Vibration Control of Active Structures", Springer 2018, ISBN: 9783319722962
3. S.S. Rao, "Mechanical Vibrations", 5th Edition 2004, Pearson Publications
4. Clarence de Silva, "Vibration: Fundamentals and Practice",1st Edition 2000, CRC Press, ISBN: 0849318084

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112104211– Principles of Vibration Control, IIT Kanpur

https://nptel.ac.in/courses/112107088– Vibration control, IIT Roorkee

Course Code	Course Name	Credits
MEDLO7043	**Advanced Vibration**	**03**

Objectives :

1. To study the Multi-degree of freedom system.
2. To study different vibration measurement and control methods, and required instruments.
3. To study basic concepts of Random Vibrations.
4. To study the basic concepts of nonlinear vibrations.

Outcomes: Learner will be able to…

1. Estimate natural frequency of mechanical element / system.
2. Understand the concepts of Vibration Isolation and Control.
3. Analyse vibratory response of mechanical element / system.
4. Analyse vibration of Continuous system.
5. Analyse Random Vibrations.
6. Analyse Non-Linear Vibrations.

Module	Contents	Hours
1	**Multi Degree of Freedom System:** **1.1 Undamped free vibration:** Free vibration equation of motion, Influence coefficients (stiffness and flexibility), Reciprocity theorem, Generalized Coordinates, and Coordinate Coupling, Lagrangian equations, Rayleigh and Dunkerley method, two rotor and geared systems **1.2 Eigen Values and Eigen vectors:** for translatory and torsional two d.o.f. systems, Matrix method, Holzer's method (translatory and torsional unbranched systems)	**06**
2	**2.1 Vibration Isolation and Control:** Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, vibration isolation, Dynamic vibration absorbers, and Vibration dampers, Passive, semi-active, and active vibration control	**06**
3	**3.1 Vibration Measurement:** Introduction, Transducers, Vibration pickups, Frequency measuring instruments, Vibration exciters, Signal analysis. **3.2 Modal analysis and Condition Monitoring:** Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine condition monitoring and diagnosis.	**06**
4	**Vibration of Continuous Systems:** Vibration of string, Longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.	**07**
5	**Random Vibrations:** Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms and response.	**07**

6	**Non-Linear Vibrations:** Introduction, Sources of nonlinearity, Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations, Runge-Kutta method.	**07**

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**.

Text/Reference Books:

1. W.T. Thomson and M.D. Dahleh, "Theory of Vibration with Applications", 3rd Edition 2002, Pearson Education
2. G.K. Grover, "Mechanical Vibraitons", 5th Edition 2009, Nem Chand and Bros, ISBN: **978-8185240565**
3. W.W. Seto, "Mechanical Vibrations- Schaum's Outline Series", McGraw Hill, ISBN: 9780070563278
4. S.S. Rao, "Mechanical Vibrations", 5th Edition 2004, Pearson Publications
5. Leonard Meirovitch, "Fundamentals of Vibration", 1st Edition 2010, McGraw Hill, ISBN: 978-1577666912.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112107212 – Introduction to Mechanical Vibration, IIT Roorkee
https://nptel.ac.in/courses/112103111 – Mechanical Vibrations, IIT Guwahati
https://nptel.ac.in/courses/112103022 – Nonlinear Vibration, IIT Guwahati
https://nptel.ac.in/courses/112104211 – Principles of Vibration Control, IIT Kanpur

Course Code	Course Name	Credits
ILO7011	**Product Life Cycle Management**	**03**

Objectives:

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

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant
5.

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	**10**
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	**09**
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	**05**

04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	**05**
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	**05**
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	**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)

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**.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 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

Course Code	Course Name	Credits
ILO7012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Sr. No.	Detailed Contents	Hrs
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**

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**.

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.

Course Code	Course Name	Credits
ILO7013	**Management Information System**	**03**

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

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

Sr. No.	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

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**.

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

Course Code	Course Name	Credits
ILO7014	**Design of Experiments**	**03**

Objectives:

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

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Sr. No	Detailed Contents	Hrs
01	**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
02	**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
03	**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
04	**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	07

	4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	
05	**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
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

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**.

REFERENCES:

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

Course Code	Course Name	Credits
ILO7015	**Operations Research**	**03**

Objectives:

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

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. 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.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Sr. No.	Detailed Contents	Hrs
01	**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
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05

03	**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
04	**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
05	**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
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	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)

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**.

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

Course Code	Course Name	Credits
ILO7016	**Cyber Security and Laws**	**03**

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Sr. No.	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, 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
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6

06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

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**.

REFERENCES:

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

Course Code	Course Name	Credits
ILO7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Sr. No.	Detailed Contents	Hrs
01	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
02	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
03	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 co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of	06

	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.	
05	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
06	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. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

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**.

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)

Course Code	Course Name	Credits
ILO7018	**Energy Audit and Management**	**03**

Objectives:

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

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Sr. No	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers.	10

	Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**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
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment 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.

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

Course Code	Course Name	Credits
ILO7019	**Development Engineering**	**03**

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
3. 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
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Sr. No.	Detailed Contents	Hrs
01	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**
02	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**
03	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**

04	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**
05	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**
06	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**

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

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 andPractice, Vol. 4, No.4, pp.395 – 407

Course Code	Course Name	Credits
MEL701	**DESIGN OF MECHANICAL SYSTEMS**	**01**

Objectives:

1. To familiarize with the concept of system and methodology of system design
2. To study system design of various systems such as Gear box, snatch block, belt conveyors, I. C. engine system and pumps
3. 3To familiarize with the standard codes of professional practices in designing the various systems

Outcomes: Upon successful completion of this course, the learner will be able to …

1. Apply the concept of system design.
2. Design of hoisting mechanism of EOT crane,
3. Design belt conveyor systems
4. Design pumps for the given applications
5. Design engine components such as cylinder, piston, connecting rod and crankshaft

Term Work:	**Comprises of Part - A & Part -B**
Module	**Details**
Part A	**1. DESIGN AND DETAILED ASSEMBLY DRAWING :**
	a) Computer aided Design and detailed assembly drawing (**A3 size sheets)** of **any one** design problem, from any CAD software
	i) Design of hoisting mechanisms
	ii) Design of belt conveyors
	iii) Design of Engine
	b) Design and detailed assembly drawing (Full Imperial drawing sheet 762x559 mm) of **any one** design problem from the following:
	i) Design of Gear box
	ii) Design of pumps
	2. COURSE PROJECT :
	Students in a group of two to four should be able to apply and integrate the knowledge gained during the course. Design and preparation of working drawings of any system having minimum 5 to 6 components is expected. Course project may be given as development of software program using python, VB, C++, EXCEL etc for mechanical systems
Part B	**ASSIGNMENT :**
	Exercises on following topics in the form of design calculations with sketches and / or drawings.
	1. Engine design (SI/CI engine)
	2. Design of gearbox (As mentioned in theory)

	3. Design of Pump
	4. Design of Belt conveyor
	5. Design of Hoisting mechanism
	The distribution of marks for term work shall be as follows:
	□ Exercises and Drawing sheets : 10 marks.
	□ Assignments : 05 marks
	□ Course Project : 05 marks.
	□ Attendance : 05 Marks.
	ASSESSMENT :
	End Semester Practical/Oral examination:
	1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
	2. Distribution of marks for practical-oral examination shall be as follows:
	Design Task : 15 marks
	Oral : 10 marks
	3. Evaluation of practical/oral examination to be done based on the performance of design task
	4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL702	**Maintenance Engineering Lab**	**1**

Objectives

1. To familiarize with Maintenance Procedures and Strategies.
2. To acquaint with the process of Condition Monitoring and Machinery Fault Diagnosis.

Outcomes: Learner will be able to….

1. Identify different tools used for maintenance.
2. Apply different maintenance strategies.
3. Demonstrate the process of servicing a machine.
4. Identify common faults in Machinery using Vibration Spectrum.
5. Interpret the Vibration Signals for Monitoring and Prognosis.

Sr. No.	List of Exercises
1.	Identifications of different Tools used for maintenance (Spanner, Plier, Screw Driver, Allen Keys, Puller etc.)
2.	Dismantling and assembly of any one mechanical system (Gearbox, pumps, Injector, Fuel Pump, Tailstock etc.) (One job in a group of 4-5 students)
3.	Case studies based on Maintenance strategies (Breakdown, preventive, predictive and proactive)
4.	Machinery Servicing (Greasing, Oiling, Cleaning etc.)
5.	Condition Monitoring and Machinery Fault Diagnosis – Unbalance
6.	Condition Monitoring and Machinery Fault Diagnosis – Misalignment
7.	Condition Monitoring and Machinery Fault Diagnosis – Bent Shaft
8.	Condition Monitoring and Machinery Fault Diagnosis – Mechanical Looseness
9.	Condition Monitoring and Machinery Fault Diagnosis – Bearing Defects
10.	Condition Monitoring and Machinery Fault Diagnosis – Defects in gears
11.	Condition Monitoring and Machinery Fault Diagnosis – Defects in pumps
12.	Condition Monitoring and Machinery Fault Diagnosis – Defects in fans
13.	Condition Monitoring and Machinery Fault Diagnosis – Defects in blowers

Note :

1. **First four experiments are mandatory. At least four experiments to be performed from the remaining.**
2. **A visit of students to an automobile service station/any other machinery maintenance workshop shall be arranged as a part of the above exercises.**

Assessment:

Distribution of marks for term work
Laboratory work 20 Marks
Attendance 05 Marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
   a. Practical performance 15 marks
   b. Viva 10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination.

References:

1. A.R. Mohanty, "Machine Condition Monitoring: Principles and Practices", CRC Press
2. R.A. Collacott, "Mechanical Fault Diagnosis and Condition Monitoring", Chapman and Hall

NPTEL

https://nptel.ac.in/courses/112105232 – Machinery Fault Diagnosis and Signal Processing, IIT Kharagpur

Course Code	Course Name	Credits
MEL703	**Industrial Skills**	**01**

Course Rationale: This course has been designed to prepare final year mechanical engineering students for placements, as well as to build computer skills and advanced soft skillsto make them ready for a career in the industry.

Objectives:

1. To familiarise mechanical engineering students with basiccomputer/IT skillsin the industry.
2. To practise soft skills and communication to be industry-ready.
3. To inculcate critical thinking and problem-solving abilities for efficient team and project outcomes.
4. To be prepared for campus placements by practising aptitude, logical reasoning, Group discussion and personal interview rounds.

Outcomes: At the end of the course, **the learners will be able to**

1. Skilfully prepare and edit documents and slides on MS Word and MS PowerPoint etc.
2. Execute functions on MS Excel.
3. Learn how to navigate tasks and execute functions in G-suite.
4. Understand and practice metacognitive skillsof creativity and problem solving.
5. Hone team building and leadership skills.

Perform well in campus placement rounds by practising Aptitude, Logical reasoning, Group Discussion and Personal Interviews.

Module	**List of Experiments and Activities**	**No. of La sessions (*2hrs)**
1	**Computer/IT skills**	6
1.1	Basics of Computers- Desktop/Laptop operations	
1.2	Microsoft Office	
1.2.1	• **MS Word**- Assignment to Create and use various commands in a Word document (Page setup, text formatting, templates, SmartArt, Title and Ribbon bar, Editing etc.)	
1.2.2	• **MS Excel**- Assignment to Create and tabulate a spreadsheet (Excel- data analysis, charts, pivot tables, VBA, etc.)	
1.2.3	• **MS- Power point**- Assignment to design and use a Presentation Software(MSPPT, Prezi, etc. – Presentation	

1.2.4 1.3 1.4	design, templates, custom slides, animation, graphs, charts, troubleshooting etc.) • **MS Outlook** (Navigation, archiving, tasks distribution, filters, scheduling etc.) • G-Suite (Gmail, G-Meet, Calendar, Sheets, Docs, Slides etc.) • An introduction to the typesetting package LATEX.	
2	**Aptitude and Logical Reasoning**	2
2.1 2.2	Aptitude – Aptitude training, types of questions, mock tests Logical Reasoning – Verbal and Non-verbal reasoning, Types of questions, Mock tests	
3	**Developing Metacognitive skills**	2
3.1 3.2	Task orientation and Goal setting (can be based on Final year Project): Creativity and Problem-solving	
4	**Collaborative Techniques:Team building skills**	1
4.1 4.2	Activities on Team building Case studies on Leadership, Decision making and Team building	
5	**GD – PI**	2
5.1 5.2	Group Discussion – Factual, Strategic, Abstract, Case study, Picture based Personal Interview–Types of Interview Questions, Strategies, Sample answers, Mock Interviews	

Assignments: Assignments and activities should enable a steady progress in developing the aforementioned skills.A record of the conducted activities can be attached in journal as image printouts, and write up of case studies.

1. Application of MS Office skills (Individual)
   - Create and edit Word documents
   - Create and execute MS Excel functions
   - Create and enhance MS PPT
2. Writing a simple document in LATEX editor and running the typesetter program to produce finished document
3. Aptitude and Logical reasoning tests/practice sheets

4. Team building skills: Activities/Tasks to be performed as a team of 3 or 4 students.
5. Group Discussions

Case studies on problem-solving to be done as a team activity.

Personal Interview questionslog book

Assessment: Total – 50 Marks

Marks distribution will be as follows:

FINAL TERM WORK – 25 Marks

Assignments (Journal) – 20 Marks

Attendance - 05 Marks

ORALS/Written – 25 Marks

1. **Aptitude Test (Written) - 15 Marks**
2. **Mock Interview (Orals) – 10 Marks**

Books recommended/References/ Resources:

1. Meenakshi Raman, Prakash Singh. *Business Communication*, Oxford University Press, 2012
2. Claudyne Wilder. *The Presentations Kit*: 10 steps for Selling Your Ideas, John Wiley & Sons, 1994.
3. Lesikar, Flatley. *Basic Business Communication*: Skills for Empowering the Internet Generation, Tata McGraw Hill, 2008.
4. Flavell, J. H. *Cognitive development*: Past, present, and future. 1992.
5. Thorpe, Edgar and Showick Thorpe. *Objective English*, Pearson, 2013. (7th edition Amazon)
6. Thorpe, Edgar. *Test of Reasoning*: for All Competitive Examination. 7th edition., Amazon
7. Sinha, Nishit K., *Reasoning*, Pearson.
8. Aggarwal, R.S., *A Modern Approach to Logical Reasoning*, S. Chand.
9. Weblinks - https://cambridge-community.org.uk/professional-development/gswmeta/index.html
10. Various Quantitative aptitude books and websites listhttps://eduly.in/best-quantitative-aptitude-books/
    https://prepinsta.com/learn-aptitude/
    https://www.simplilearn.com/learn-ms-excel-free-training-course-skillup

NPTEL

Creativityhttps://nptel.ac.in/courses/109101017

Course Era

MS Excelhttps://www.coursera.org/projects/introduction-microsoft-excel
G-suite https://www.coursera.org/projects/collaborating-g-suite-apps
Problem solving https://www.coursera.org/learn/problem-solving

Udemy

G-suite https://www.udemy.com/course/learn-gsuite/

Course Code	Course Name	Credits
MEP701	**Major Project 1**	**03**

Objectives: The course aims:	
The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.	
Outcomes:	
1	Students will be able to develop the understanding of the problem domain through extensive review of literature.
2	Students will be able to identify and analyze the problem in detail to define its scope with problem specific data.
3	Students will be able to identify various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4	Students will be able to design solutions for real-time problems that will positively impact society and environment..
5	Students will be able to develop clarity of presentation based on communication, teamwork and leadership skills.
6	Students will be able to inculcate professional and ethical behavior..

Guidelines:

1. **Project Topic Selection and Allocation:**

- Project topic selection Process to be defined and followed:
  - Project orientation can be given at the end of sixth semester.
  - Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
  - Student's should be recommended to refer papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
  - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.
- Topics can be finalized with respect to following criterion:
  - **Topic Selection**: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.

- **Technology Used:** Use of latest technology or modern tools can be encouraged**.**
- Students should not repeat work done previously (work done in the last three years).

- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- Head of department and senior staffalong with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and studentshave to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels.

2. **Project Report Format:**

At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey
  - Survey of Existing systems
  - Limitations of Existing systems or research gaps
  - Motivation (Challenges that are encouraging to choose the problem)
  - Problem Statement and Proposed Solution
  - Scope of the system
- Proposed System
  - General Workflow/Block diagram
- Analysis and Modeling (only applicable diagrams)
- Design
  - Architectural View
  - Algorithms/ Methodology
- Experimental Set up
  - Details of Database or details about input to systemsor selected data
  - Performance Evaluation Parameters (for Validation)
  - Software and Hardware Set up
- Implementation Plan for Next Semester
  - Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- Summary
- References

Desirable

- Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

3.Term Work:

Distribution of marks for term work shall be done based on following:

a. Weekly Log Report
b. Project Work Contribution
c. Project Report (Spiral Bound) (both side print)
d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral & Practical:

Oral &Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as follows:

1. Quality of problem selected
2. Clarity of problem definition and feasibility of problem solution
3. Relevance to the specialization / industrial trends
4. Originality
5. Clarity of objective and scope
6. Quality of analysis and design
7. Quality of written and oral presentation
8. Individual as well as team work