

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)

University of Mumbai



Title of Course	B.E. (Mechanical Engineering)
Eligibility	Ordinance 0.6244
Passing Marks	40%
No. of years/Semesters:	8 semesters
Level:	P.G. / U.G./ Diploma / Certificate
Pattern:	Yearly / Semester
Status:	New / Revised
To be implemented from Academic Year :	2022-23

Dr. Vivek Sunnapwar
Chairman
of Board of Studies in
Mechanical Engineering

Dr. Suresh K. Ukarande
Associate Dean,
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Dr Anuradha Majumdar
Dean,
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Preamble

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

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 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.

Dr. S. K. Ukarande
Associate Dean
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Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
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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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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
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Dr. Milind Deshmukh	: 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)			
		Test1	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

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract.	Total
MEC801	Operations Planning and Control	3	--	3	--	3
MEDLO805X	Department Level Optional Course – 5	3	--	3	--	3
MEDLO806X	Department Level Optional Course – 6	3	--	3	--	3
ILO802X	Institute Level Optional Course – 2*	3	--	3	--	3
MEL801	Product Design and Development	--	2	--	1	1
MEL802	Laboratory based on IoT	--	2	--	1	1
MEP801	Major Project II	--	12 [#]	--	6	6
Total		12	16	12	8	20

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac./Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (Hrs)			
		Test1	Test2	Avg					
MEC801	Operations Planning and Control	20	20	20	80	3	--	--	100
MEDLO805X	Department Level Optional Course – 5	20	20	20	80	3	--	--	100
MEDLO806X	Department Level Optional Course – 6	20	20	20	80	3	--	--	100
ILO802X	Institute Level Optional Course – 2*	20	20	20	80	3	--	--	100
MEL801	Product Design and Development	--	--	--	--	--	25	25	50
MEL802	Laboratory based on IoT	--	--	--	--	--	25	25	50
MEP801	Major Project II	--	--	--	--	--	100	50	150
Total		--	--	80	320	--	150	100	650

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

* Common with all branches

Students group and load of faculty per week.

Major Project 1 and 2:

Students can form groups with minimum 2 (Two) members and not more than 4 (Four) members

Faculty Load: In Semester VII – ½ hour per week per project group

In Semester VIII – 1 hour per week per project group

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

Course Code	Sem. VIII: Department Optional Course- 5	Course Code	Sem. VIII: Department Optional Course - 6
MEDLO8051	Composite Materials	MEDLO8061	Product Design and Development
MEDLO8052	Smart Materials	MEDLO8062	Design for X
MEDLO8053	Micro Electro Mechanical Systems	MEDLO8063	Total Quality Management

Institute Optional Courses

Course Code	Institute Optional Course-I #	Course Code	Institute Elective Course-II #
ILO7011	Product Lifecycle Management	ILO8021	Project Management
ILO7012	Reliability Engineering	ILO8022	Finance Management
ILO7013	Management Information System	ILO8023	Entrepreneurship Development and Management
ILO7014	Design of Experiments	ILO8024	Human Resource Management
ILO7015	Operation Research	ILO8025	Professional Ethics and CSR
ILO7016	Cyber Security and Laws	ILO8026	Research Methodology
ILO7017	Disaster Management and Mitigation Measures	ILO8027	IPR and Patenting
ILO7018	Energy Audit and Management	ILO8028	Digital Business Management
ILO7019	Development Engineering	ILO8029	Environmental Management

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. 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.	04
2.	Design of Transmission Gear Box: Single stage and Two 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.	12
3.	Design of Hoisting Mechanism: 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.	10
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	10
6.	Design of Pump: 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	08

	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 Design”, 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 (CO2 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 transshipment 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.

University of Mumbai

B. E. (Mechanical Engineering), Rev 2019

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 Altekhar, “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	Details	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	06

	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)	
3.	Engine Exhaust Emission and its control Constituents of exhaust emission at its harmful effect on environment and human health, Formation of NO_x, 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. Single line diagram of charging station, On board Charger. Payback period of EV and HEV Case Study: Toyota Prius, Honda Insight, Tata Nexon EV	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 Books:

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, Yimi Gao, 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.	07

	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 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.	07

	5.2: Hydrogen Energy: Introduction and application, General introduction to infrastructure requirement for hydrogen production, 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
MEDLO7033	Vehicle Systems	03

Objectives:

1. To study basic and advanced vehicle systems
2. To study basic and advanced vehicle electrical systems
3. To study different chassis structures components.
4. To familiarize with the latest technological developments in automotive technology

Outcomes: Learner will be able to

1. Understand the working of different Vehicle Systems and Subsystems.
2. Understand the working of different Vehicle Electrical systems and subsystems.
3. Understand different Vehicle Body systems and layouts.
4. Illustrate working, functions of different vehicle mechanical, electrical, and chassis systems.
5. Understand the effect of aerodynamics on the functioning of a vehicle.
6. Comprehend the different technological advances in vehicle systems.

Module	Details	Hours
1.	Power Flow Layout: FE FWD,FE RWD,RE FWD,RE RWD, Underfloor Engine Clutches: Necessity of clutch in a automobile, Working and Construction of Single plate, Multi plate, Centrifugal, Semi Centrifugal, electromagnetic clutches, Fluid Flywheel Transmission: Purpose and Elements of Gear Box, Characteristic Curves, Types-Sliding mesh, Constant Mesh, Synchromesh, Planetary Gear set, Torque Converter, Semi-Automatic and Automatic Drive Line:	08

	UV joint, CV joint, Propeller Shaft construction and arrangement, Elements of drive line, 2WD, 4WD, Part time and Full time 2WD and 4WD.	
2.	Final Drive Types of Final drive; spiral, bevel, Hypoid and worm drives. Differential Necessity of differential, Working of differential, Conventional and non-slip differential. Axles : Types of live axles; semi, three quarter and full floating axles. Types of Front Stub Axles; Elliot, Reverse Elliot, Lamoine and Reverse Lamoine Steering: Requirement, Types of Steering Gear Box, Steering Geometry, Wheel Alignment and Wheel balancing, Power Steering Brakes: Principle, Types; Hydraulic, Air, Electric, Exhaust, Regeneration , Brake lining materials, ABS, EBD	08
3.	Suspension: Requirement and Types-Independent, Dependent, Air. Types of Shock absorbers , Leaf spring types Wheels and Tyres: Tyre requirement, tire characteristics, Constructional detail, , tyre dimensions and specifications, Types of wheels and Hubs	06
4.	AUTOMOTIVE ELECTRICAL SYSTEMS Batteries: Construction, Types: Lead Acid, Alkaline, Nickel Metal Hydride, Lithium Ion, Battery Ratings, Battery Charging Starting:	08

	Requirement, Starter Motor Drives, cold cranking Amperes Charging: Requirement, Principle and Construction of Dynamo and Alternator Ignition: Mechanical and Electronic Ignition and Electronic Engine Control Lighting and Wiring: Types of Lamps, Gauges, Cable Sizes, Color Codes, Multiplex Wiring systems Accessories: Electric Horn, Wipers, Fuel Pumps, Power operated windows, Fuel Gauges, OBD systems	
5.	Body Engineering: Chassis types and Structure types-Open, Semi Integral and Integral, Loads acting on chassis, Basic Dimensions and Visibility Vehicle Aerodynamics : Aerodynamic drag: Aerodynamic lift and Pitching moments, Side force, Yawing & Rolling moments.	06
6.	Recent Technological Developments in Automobile: Telematics, Intelligent Vehicles systems, V2V and V2I communication. Scope of AI in Automobile Vehicle	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.**

Text Books:

1. Automobile Engineering, Kirpal Singh, Vol I & II, Standard publishers Distributors ,Delhi
2. J Powloski, “Vehicle Body Engineering”, Business Books Ltd., London
3. Automobile Mechanics, N. K. Giri, 8thEdition, Khanna Publishers
4. P. L. Kohli, “Automotive Chassis & Body”, Papyrus Publishing House, New Delhi.
5. Tom Denton, Automobile Electrical and Electronics System, Elsevier Third Edition, 2003

Reference Books :

1. John Fenton, “Vehicle Body Layout & Analysis”, Hutchinson, London.
2. Bosch Automotive HandBook, 6thEdition, SAE Publications
3. Automotive Mechanics by William H. Crouse and Donald L. Anglin, 10th Edition, McGraw Hill

Links for online NPTEL/SWAYAM courses:

1. <https://nptel.ac.in/courses/107106088>
2. <https://nptel.ac.in/courses/107103084>
3. <https://nptel.ac.in/courses/113106082>

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 Rolling element bearing and Journal Bearing fault diagnosis, Faults related to Gearbox, vane defects in pumps, Fault in Fans and Blowers.	06
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”, Wiley 2021, 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 absorber, semi-active tuned vibration absorber	05
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 Vibrations”, 5th Edition 2009, Nem Chand and Bros, ISBN: **978-8185240565**
3. W.W. Seto, “Mechanical Vibrations- Schaum's Outline Series”, McGraw Hill, ISBN: [9780070563278](https://www.mhprofessional.com/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,	05

	Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	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, Fault 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-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "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 General 2^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. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

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 Lieberman, 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 recognize 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. Kenneth 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 emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
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 and Practice, 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 Gear box.
3. Design of 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

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. Methodology & Morphology of design
	2. Design of gearbox (As mentioned in theory)
	3. Design of Hoisting mechanism
	4. Design of Belt conveyor

	5. Engine design (SI/CI engine)
	6. Design of Pump
	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 skills to make them ready for a career in the industry.

Objectives:

1. To familiarise mechanical engineering students with basic computer/IT skills in 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 skills of 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	design, templates, custom slides, animation, graphs, charts, troubleshooting etc.) • MS Outlook (Navigation, archiving, tasks distribution, filters, scheduling etc.)	
1.3	• G-Suite (Gmail, G-Meet, Calendar, Sheets, Docs, Slides etc.)	
1.4	• An introduction to the typesetting package LATEX.	
2	Aptitude and Logical Reasoning	2
2.1	Aptitude – Aptitude training, types of questions, mock tests	
2.2	Logical Reasoning – Verbal and Non-verbal reasoning, Types of questions, Mock tests	
3	Developing Metacognitive skills	2
3.1	Task orientation and Goal setting (can be based on Final year Project):	
3.2	Creativity and Problem-solving	
4	Collaborative Techniques: Team building skills	1
4.1	Activities on Team building	
4.2	Case studies on Leadership, Decision making and Team building	
5	GD – PI	2
5.1	Group Discussion – Factual, Strategic, Abstract, Case study, Picture based	
5.2	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 questions log 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 list <https://eduly.in/best-quantitative-aptitude-books/>
<https://prepinsta.com/learn-aptitude/>
<https://www.simplilearn.com/learn-ms-excel-free-training-course-skillup>

NPTEL

Creativity <https://nptel.ac.in/courses/109101017>

Course Era

MS Excel <https://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 staff along with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and students have 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 systems or selected data
 - Performance Evaluation Parameters (for Validation)
 - Software and Hardware Set up
- Implementation Plan for Next Semester
 - Timeline Chart for Term-I 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. Term work evaluation:

Term work evaluation for Project 1 should be conducted by Internal examiner on continuous basis throughout 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

Course Code	Course Name	Credits
MEC801	Operations Planning and Control	03

Objectives:

1. To provide an exposure to Operations Planning & Control (PPC) and its significance in manufacturing and service organizations
2. To appraise about need and benefits of planning functions related to products and processes
3. To provide exposure to production scheduling, sequencing and project management so as to optimize resources
4. To provide insights into MRP and ERP to minimize the total cost and to manage operations functions in a better way
5. To demonstrate different techniques used for facility planning and assembly line balancing
6. To develop an understanding of JIT, Lean, Agile and Synchronous Manufacturing system

Outcomes: Learner will be able to...

1. Illustrate operations functions and manage operations in a better way.
2. Apply various strategies to develop aggregate production plan based on the demand forecasting.
3. Apply various algorithms in scheduling and sequencing of manufacturing and service operations
4. Develop Material Requirements Plans (MRP) to estimate the planned order releases.
5. Apply various techniques for facility layout planning and line balancing to optimize the resources
6. Demonstrate the importance of implementation of JIT, Lean, Agile and Synchronous manufacturing in manufacturing and service organizations.

Module	Contents	Hours
1	1.1 Introduction: Production and Operations Function, Production systems, Make to stock, Make to order, Assemble to order and Engineer to order, type of layouts, Phases in OPC like Preplanning, Planning, Action & Control. 1.2 Strategic Planning for Operations and Services: Approaches like Forced Choice model and Operations Model, Quality and Productivity strategy, Technology strategy. Operations Strategies for Services, Types or Service Operations: Quasi manufacturing, Customer as participants, Customer as product, Classification of Services, Service capacity.	06
2	2.1 Forecasting: Forecasting and Prediction, Need for forecasting, role of forecasting in OPC, Methods of forecasting, Qualitative methods, Quantitative methods like time series analysis, least square method, moving average method, and exponential smoothing method. Forecasting Error; Mean Absolute Deviation, Forecasting Bias 2.2 Capacity Planning: Measurement of capacity, Measures of operating capacity, Factors influencing effective capacity, factors favouring over capacity and under capacity, short range, medium range and long range capacity planning. Capacity requirement Planning (CRP)	08

	2.3 Aggregate planning: Concept of aggregate planning, Pure Strategy; Mixed Strategy; Level Strategy, Rough cut capacity planning, Aggregate planning for Services; Optimal Models for Aggregate Planning; Linear Programming; Linear Decision Rules Master Production Schedule	
3	3.1 Job shop/Intermittent Manufacturing Scheduling: Factors influencing scheduling, Inputs for scheduling, Forward Scheduling, Backward Scheduling, Stages in Scheduling: Product sequencing, Loading and Dispatching, dispatching, progress report & expediting and control. Basic scheduling problems, Priority Sequencing, Gantt Charts, Johnson's Rule for optimal sequence of N jobs on 2 machine. Process N Jobs on 3 Machines (N/3 problem) and Jackson Algorithm. Processing of 2 Jobs on M Machine (2/M) problem, 3.2 Project scheduling: Network analysis - PERT & CPM, cost analysis & crashing, resource leveling and smoothening.	08
4	4.1 Material Requirement Planning: Introduction, Limitations of conventional EOQ, Objectives of MRP, Inputs of MRP-I, Outputs of MRP, MRP lot sizing and Estimation of planned order releases, Manufacturing resource planning (MRP-II) 4.2 Enterprise Resource Planning (ERP): Evolution, features, purpose of modeling an enterprise, ERP model for OPC, Modules in ERP, ERP Implementation Life Cycle, ERP packages like SAP-R3/Baan/PeopleSoft,	06
5	5.1 Facility layout planning: Factors influencing Plant Layout, Material Flow Patterns, Tools and Techniques used for Plant Layout Planning. 5.2 Line Balancing: Objectives, constraints, terminology in assembly line, heuristic methods like Kilbridge-Wester, Largest Candidate rule, Rank positional weight	06
6	Introduction to JIT system, Lean, Agile and Synchronous manufacturing: Concept, Characteristics, Components and Implementation.	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.

Text/Reference Books: -

1. "Production and Operations Management", K. Aswathappa & K. Shridhara Rao, Himalaya Publishing House, Revised 2nd Edition (2008)
2. "Industrial Engineering and Production Management", Martand Telsang, S. Chand, New Delhi (2009)
3. "Modern Production operations Management", Elwood S Buffa and Rakesh K Sarin, 8th Edition, Wiley Eastern, New York (1999) ISBN: 978-0471819059
4. "Production and Operations Management", Panneer Selvan R, 3rd Edition 2002 Prentice Hall India, New Delhi, ISBN: 978-8120345553
5. "Production Planning and Control", Samuel Eilon, Universal Publication, ISBN: 9788185027548
6. "Production Planning and Control", L C Jhamb, 12th Edition 2010, Everest Pub House.
7. "Production Planning and Control", W. Boltan-Longman Scientific & Technical (1994), ISBN: 978-0582228207
8. "Production Systems- Planning, Analysis & Control", James. L. Riggs, John, 4th Edition 1987, Wiley & Sons, ISBN: 9780471847939
9. Manufacturing Planning and Control Systems, Thomas E. Vollman, William L. Berry & Others, 4th Edition 1997, McGraw Hill Pub, ISBN: 978-0786312092
10. "Manufacturing Process Planning and Systems Engineering", Anand Bewoor, Dreamtech Press 2009, ISBN: 978-8177229967
11. "Production and Operations Management", S.N. Chary, 3rd Edition 2004, TMH publishing company, ISBN: 978-0070583559
12. Modernization & Material Management, L.C. Jhamb - Everest Publishing House

Course Code	Course Name	Credits
MEDLO8051	Composite Materials	03

Objectives

1. To study the manufacturing methods of composite material.
2. To study the behaviour of composite materials, both at micro and macro levels.
3. To study the procedure of designing a composite laminate and structure as a whole for the given application.
4. To study the applicability of composite materials for various industrial/loading applications
5. To study the damage detection and damage repair methods for composite materials

Outcomes: Learner will be able to...

1. Select the type of material for the fibres and matrix in a composite material for the given application.
2. Relate stresses and strains through the elastic constants for a given lamina.
3. Evaluate elastic properties of a lamina based on the properties of its constituents.
4. Predict failure of a lamina under the given loading condition.
5. Select the number of laminae and their stacking sequence in a composite material for the given loading condition.
6. Identify the type of damage occurring in a composite structure and select an appropriate method to repair it.

Module	Contents	Hours
1	Introduction Classifications based on fibres and matrix, Advantages, Applications, Terminology, Manufacturing Methods: Hand layup, Spray layup, Vacuum bagging, Prepregs, Industrial autoclave, Filament winding, Pultrusion, Resin transfer moulding, Vacuum Infusion Processing, Powder metallurgy route for ceramic and metal matrix composites	08
2	Analysis of Lamina Hooke's law for different types of materials, Plane stress assumption, Hooke's law for a two-dimensional unidirectional lamina, Relationship of compliance and stiffness matrix to engineering elastic constants of a lamina, Hooke's law for a two-dimensional angle lamina, Engineering constants of an angle lamina	06
3	Lamina Failure Theories Introduction, Maximum stress failure theory, Maximum strain failure theory, Tsai-Hill failure theory, Tsai-Wu failure theory, Strength ratio, Failure envelopes	04
4	Introduction to Micromechanics of Lamina and Laminate Design Prediction of mechanical properties of lamina based on properties of its constituents (fibre and matrix), Laminate types and their codes, Overview of laminate design (no problems on this topic)	06

5	Inspection of Composites Different types of damages in composites, Non-destructive testing of composites: Ultrasonics inspection, Acoustography, Low frequency Methods, Radiographic inspection, Shearography, Acoustic emission, Thermography	06
6	Repair of Composites Restitution and repair of composites: Selection of Repair method, Repair criteria, Generic repair designs, Matrix cracks, Delamination, Holes and Fiber fracture, Damage removal and surface preparation	06

Text Books:

1. M.Balasubramanian, “Composites materials processing” ,1st edition, CRC press 2013.
2. A.K. Kaw, “Mechanics of Composite Materials”, Taylor and Francis Group, ISBN: 9780815351481
3. Ajay Kapadia, “Non Destructive Testing of Composite Materials”, National Composites Network
4. R.B. Heslehurst, “Defects and Damage in Composite Materials and Structures”, CRC Press 2014.

References:

1. R.M. Jones, “Mechanics of Composite Materials”, 2nd Edition,Taylor and Francis, Inc,ISBN: 9781138571075
2. I.M. Daniel and O. Isai, “Engineering Mechanics of Composite Materials”, 2nd Edition 2005,Oxford University Press, ISBN: 9780195150971
3. D. Gay, S.V. Hoe, and S.W. Tsai, “Composite Materials: Design and Applications”, 3rd Edition 2014, CRC Press, ISBN: 978-1466584877
4. R.B. Heslehurst, “Defects and Damage in Composite Materials and Structures”, CRC Press 2014.
5. [M.M. Schwartz](#), “Composite Materials: Properties, Nondestructive Testing, and Repair”, Prentice Hall PTR (1997), ISBN: 9780133000474

Course Code	Course Name	Credits
MEDLO8052	Smart Materials	03

Objectives

1. To study the working principles of various smart materials.
2. To identify applicability of various smart materials as actuator and sensor.
3. To study advances in smart materials

Outcomes: Learner will be able to...

1. Classify and select different types of smart materials
2. Comprehend Important Concepts and principles of Smart Materials
3. synthesis, sensing and actuation of Piezoelectric Materials, Magneto strictive Materials, Shape Memory Alloys, Electroactive Polymers
4. synthesis, sensing and actuation of Ferrofluids and Magneto rheological Fluids, Soft Matter, Carbon Nanotubes and Carbon nanostructures, Thermoelectric Materials
5. Classify and select Smart Materials for Energy Applications: Materials used for energy storage
6. Classify and select Composite Materials, Nano Composite Materials

Module	Contents	Hours
1	Introduction to Smart Materials: Overview of the different types of Smart Materials, Smart materials used in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships, concept of High bandwidth- low strain generating materials (HBLS), and Low Bandwidth High Strain Generating Materials (LBHS), Nano Composite Materials	07
2	Important Concepts of Smart Materials: artificial skins, artificial muscles, biomimetic materials, materials with tuneable responses, non-linear properties, self-healing materials, adaptive structures, self-replicating materials/structures, self-assembly, inch worm devices, hysteresis, integrated sensing and actuation	08
3	Overview of the following materials with focus on synthesis, constitutive/governing relationships, strengths and weaknesses, and applications (both sensing and actuation etc) 1. Piezoelectric Materials 2. Magneto strictive Materials 3. Shape Memory Alloys 4. Electroactive Polymers	06
4	Overview of the following materials with focus on synthesis, strengths and weaknesses, and applications 1. Ferrofluids and Magneto rheological Fluids and applications in dampers 2. Soft Matter and its applications as smart skins, smart textiles etc 3. Carbon Nanotubes and Carbon nanostructures and its applications 4. Thermoelectric Materials and Peltier devices	06

5	Smart Materials for Energy Applications: Materials used for energy storage, Hydrogen Storage Materials, Energy harvesting, Energy scavenging from vibrations	06
6	Manufacturing techniques for smart materials: micromanufacturing, high resolution lithography, LIGA process, Generative manufacturing processes such as STL, SLS, SPB, BPM, LOM, SGC, FDM, BIS, BPM, Self-assembly process, Ion beam processes,	06

Assessment:

Internal Assessment for 20 marks: Consisting of 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). Duration of each test shall be one hour.

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. M.V. Gandhi and B.S. Thompson, "Smart Materials and Structures", Chapman & Hall, London; New York, 1992 (ISBN: 0412370107)
2. Mel Schwartz, "Encyclopedia of Smart Materials Vol. I and II", John Wiley & Sons
3. SenolUtku, "Theory of Adaptive Structures : Incorporating Intelligence into Engineered Products", CRC Press (1998), ISBN: 9780849374319
4. A.V. Srinivasan, "Smart Structures: Analysis and Design", Cambridge University Press,Cambridge; New York, 2001 (ISBN: 0521650267)
5. G. Gautschi, "Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers", Springer, Berlin; New York, 2002 (ISBN:3540422595)
7. K. Uchino, "Piezoelectric Actuators and Ultrasonic Motors", Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114)
8. G. Engdahl, "Handbook of Giant Magneto strictive Materials", Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X)
9. K. Otsuka and C.M. Wayman, "Shape Memory Materials", Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X)
10. Eric Udd, "Fibre Optic Sensors: An Introduction for Engineers and Scientists", John Wiley & Sons, New York, 1991 (ISBN: 0471830070)
11. André Preumont, "Vibration Control of Active Structures: An Introduction", 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966)
12. HojjatAdeli, "Control, Optimization, and Smart Structures: High-Performance Bridges and Buildings of the Future", John Wiley, New York, 1999 (ISBN: 047135094X)
13. T.T. Soong, "Passive Energy Dissipation Systems in Structural Engineering", Wiley, Chichester; New York, 1997 (ISBN: 0471968218)

14. V.K. Wadhawan, Smart Structures: Blurring the Distinction Between the Living and Non-living , Oxford University Press, Oxford (2007) ISBN: 9780199229178
15. H.T. Banks, R.C. Smith and Y Wang, “Smart Structures: Modelling, Estimation and Control”, Wiley, New York (1996)
16. Shape Memory Alloys, (ed) D.C. Lagoudas, Springer Science (2008)
17. S.K. Ghosh , “Self-healing Materials: Fundamentals, Design Strategies and Applications, Wiley-VCH Verlag GmbH and Co. (2009), ISBN: 978-3-527-31829-2
18. Kwang J Kim and Satoshi Tadokore, “Electroactive Polymers for Robotic Applications: Artificial Muscles and Sensors”, Springer-Verlag, London (2007) ISBN: 9781846283710
19. S Priya and D J Inman, “Energy Harvesting Technologies”, Springer-Verlag (2008) ISBN: 978-0-387-76463-4
20. Moriaki Wakaki, “Optical Materials and Applications”, CRC Press (2012) ISBN: 9781315221403
21. S.S. Ray and M Bousmina, “Polymer Nanocomposites and their Applications”, American Scientific Publishers (2008)

Course Code	Course Name	Credits
MEDO8053	Micro Electro Mechanical Systems (MEMS)	03

Objectives:

1. To realize the benefits and effects of scaling.
2. To understand properties and crystallography of Silicon
3. To learn the microfabrication techniques
4. To understand the principles and uses of micro systems

Outcomes:

After taking this course, learner should be able to:

1. Apply laws of scaling for development of a MEMS device
2. Understand the materials and their processing to make MEMS
3. Select and use microfabrication techniques for microsystems
4. Understand the development of micro sensors and actuators
5. Analyze microsystems technology for technical feasibility as well as practicality
6. Develop useful applications of MEMS.

Module	Contents	Hours
1	Introduction to MEMS Unique characteristics of MEMS, Microsystems Technology- An Overview, typical MEMS and Microsystem Products, Scaling effects - scaling laws in miniaturization- Application of MEMS	05
2	Material for MEMS and manufacturing Structure of silicon and other materials - Silicon wafer processing - Bulk micromachining and Surface micromachining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching.	07
3	Micro-fabrication methods LIGA and other moulding techniques- Soft lithography and polymer processing- Thick-film processing; Low temperature co-fired ceramic processing.	06
4	MEMS components-micro sensors Micro sensors - Basic principles and working of micro sensors- Acoustic wave micro sensors- Bio-medical micro sensors- Bio-sensors- Chemical microsensors – Optical Sensors – Pressure micro sensors- Thermal micro sensors-acceleration micro sensors;	08
5	Micro-actuators Basic principles and working of micro actuators- Electrostatic micro actuators- Piezoelectric micro actuators- Thermal micro actuators- SMA micro actuators- Electromagnetic micro actuators, micro valves, micro pumps.	06
6	Case studies /research based on MEMS applications-impact of materials, processes and design, Actuation using Shape Memory Alloys, Medical device, micropumps	04

Text books:

1. MEMS and Microsystems Design and Manufacture by Tai-Ran Hsu, Tata McGraw-Hill Publishing Company Ltd.
2. Foundation of MEMS by Chang Liu, Pearson Education

References:

1. Fundamentals of Microfabrication and Nanotechnology, by Marc J. Madou, CRC Press, 2011, ISBN: 9780849331800
2. Micromachined Transducers Sourcebook, by Gregory Kovacs, WCB McGraw-Hill, Boston, 1998, ISBN: 9780071164627
3. Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes, by M.H. Bao, Elsevier, New York, 2000, ISBN: 978-0444505583
4. Microsystem Design, by Stephen D Senturia, Springer Publication, 2000, ISBN: 9780792372462.
5. Micro sensors - Principles and Applications, by Julian W. Gardner, John Wiley & Sons, Inc. 1994, ISBN: 9780471941361.

Course Code	Course Name	Credits
MEDLO8061	Product Design and Development	03

Objectives:

1. To understand the basic concepts of engineering design and product design & development, focusing on the front-end processes.
2. To demonstrate an understanding of the overview of all the product design & development processes.
3. To demonstrate knowledge of concept generation and the selection of tools.
4. To study the applicability of product design & development in industrial applications.

Outcomes: Upon satisfactory completion of this course, the student will be able to:

1. Describe the process of product design & development.
2. Employ engineering, scientific, and mathematical principles to develop and execute a design project from a concept to a finished product.
3. Create 3D solid models of mechanical components using CAD software.
4. Demonstrate individual skills using selected manufacturing techniques such as rapid prototyping.
5. Fabricate an electromechanical assembly of a product from engineering drawings.
6. Work collaboratively in a team to complete a design project.
7. Effectively communicate the results of projects and other assignments both in a written and oral format.

Module	Details	Hours
01	Need for developing products, The importance of Engineering and Industrial design, The design process, Relevance of product lifecycle issues in design, Societal considerations in Engineering and Industrial Design, Generic product development process, Various phases of product development, Planning for products, Establishing markets - market segments - relevance of market research.	7
02	The design processes, Descriptive and prescriptive design models, Concept development & evaluation, Pugh's total design activity model, Concept generation and selection method, Embodiment design, Product architecture, and Steps in developing product architecture.	7
03	Identifying customer needs, Voice of Customer (VoC), Customer populations, Hierarchy of human needs, Need gathering methods, Establishing engineering characteristics, Competitive benchmarking, Quality Function Deployment (QFD), House of Quality (HoQ), Product design specification, Development of product design with specifications using QFD, Relevant case studies.	7
04	Creative thinking, Creativity and problem-solving methods, Creative thinking methods, Brainstorming technique, Gordon technique, Check listing technique, Synectic technique, Morphological Analysis, and Attribute Listing technique. Generating design concepts, Systematic methods of designing.	7

05	Industrial design, Basic forms & elements, Integrating basic forms & elements such as balance, rhythm, proportion, The golden rule of proportions, human factors, and design, User-friendly design, Design for serviceability, Design for environment.	7
06	Concept of Design for Manufacturing and Assembly (DFMA). Role of computers in product design and manufacturing process, Prototyping techniques such as Stereolithography (SLA), Selective laser sintering (SLS), Fused deposition Modelling (FDM), Laminated object manufacturing (LOM), 3-D printing, and Ballistic Particle Manufacturing (BPM).	7

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development," 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
2. Kevin Otto, Kristin Wood, "Product Design," Indian Reprint 2004, Pearson Education, ISBN 9788177588217.

Reference Books:

1. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction," 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.
2. George E. Dieter, Linda C.Schmidt, "Engineering Design," 4th Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.
3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process," 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.

Course Code	Course Name	Credits
MELO8062	Design for X	03

Objectives:

1. To acquaint the learners with the concept of designformanufacturing and assembly
2. To acquaint the learners with the concept ofdesignfor reliability and maintainability
3. To study the product development economics.

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

1. Applydesignconcepts and guidelines formanufacturing and assembly.
2. Demonstrate the concept of value analysis and its relevance.
3. Understand the economics of product development
4. Applydesignconceptsforreliability and maintainability

Module	Contents	Hours
1.	DESIGNFORMANUFACTURE: General design principles for manufacturability-strength and mechanical factors, mechanisms selection, evaluation method, Processcapability-Feature tolerances-Geometricktolerances-Assembly limits—Datum features-Tolerance stacks	05
2.	DESIGN FOR ASSEMBLY: Assembly processes-Handling and insertion process-Manual, automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines	08
3.	VALUEENGINEERING: Introduction to Value Engineering and Value Analysis, Valuetypes-functional—operational— aesthetic, Value engineering in product design; Advantages, Applications in product design, Problem identification and selection, Analysis of functions, Anatomy of function. Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST), Case studies.	08
4.	PRODUCTDEVELOPMENTECONOMICS: Elements of Economics Analysis-Quantitative and qualitative analysis-Economic Analysis Process-Estimating magnitude and time of future cash inflows and outflows-	08

	Sensitivity analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis-Influence of qualitative factors on project success	
5.	CONCEPT OF RELIABILITY: Introduction: The study of Reliability and Maintainability, Concepts, Terms and Definitions, Applications, The Failure Distribution: The reliability Function, Mean Time to Failure, Hazard Rate Function, Bathtub Curve, Conditional Reliability	05
6.	MAINTAINABILITY: Analysis of down time, Repair Time Distribution, Stochastic Point Processes, Reliability under Preventive Maintenance, State-Dependent System with Repair, Design for Maintainability.	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. Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
2. George E Dieter, Engineering Design, McGraw-Hill International Editions, 2000
3. S.S. Iyer, Value Engineering, New Age International, 2000
4. Charles E. Ebeling, An Introduction to Reliability and Maintainability Engineering, TMH 2000.

Course Code	Course Name	Credits
MEDLO8063	Total Quality Management	03

Objectives:

1. To understand the importance of Quality Management and principles of TQM
2. To understand seven basic QC tools and advanced QM tools
3. To understand the concept of Statistical Quality Control
4. To understand the concept of Continuous Improvement and TQM implementation
5. To understand different Quality Systems and Quality Standards
6. To understand the future trends in TQM and TQM strategies

Outcomes: The students will be able to use the tools and techniques of TQM in the manufacturing and service sectors.

1. To apply QM and principles of TQM in organizational development process.
2. To apply the QC & QM tools in process improvement.
3. To apply SQC techniques to improve process quality.
4. To apply Six Sigma project in TQM Implementation
5. To apply QMS and Certification for Quality Accreditation
6. To apply the advanced tools for Quality Sustainability.

Module	Contents	Hours
1	Introduction to Quality Management : A) Definitions of Quality, product quality and service quality; the evolution of quality; need for Quality Management, Quality statements and Policy, Customer orientation & satisfaction, Customer complaints, customer retention; Supplier partnership, Supplier rating & selection, CSI, Costs of Quality, Prevention , appraisal and failure aspects , Use of COQ for improving quality and performance, Designing for quality, Quality of design, Quality of conformance. B) Basic concepts of TQM, TQM framework, Contributions of Deming, Juran and Crosby, Juran Trilogy , PDCA Cycle, Barriers to TQM; TQM principles; Strategic Quality Planning; Quality councils; employee involvement, motivation; Empowerment; Team and Teamwork; recognition and reward, performance appraisal.	08
2	QC Tools : A) Seven QC Tools: Check Sheet, Histogram, Pareto Chart, Fishbone Diagram, Run Charts, Scatter Diagram, Process Flow Chart. B) Seven QM Tools: Program Decision Process Chart, Tree Diagram, Affinity Diagram, Prioritization Matrix, etc. Bench Marking Types – Process, Product, Quality Improvement Tools: Why-Why Analysis, Root Cause Analysis, Poka Yoke (Mistake Proofing)	06

3	Statistical Quality Control: 100% Inspection versus Sampling Inspection, Reasons for SQC. A) Acceptance Sampling: Concept of Producer Risk and Consumers Risk. Operating Characteristics Curve. Sampling Plan – Single Sampling Plan versus Double Sampling Plan. Design Sampling Plan on the basis of MIL, ASQ Standards. B) Statistical Process Control: Variations – Concept, Causes – Random & Assignable, Difference – Process in Control versus Process is Capable, Control Charts, X-Bar, R, P and C Charts, Process Capability (Cp) & Process Capability Index (Cpk), Sigma Limits. Applications of Control Charts in Mass Production, Process Production.	06
4	A) Continuous Improvement: Quality Circles, Quality Function Development (QFD), Taguchi quality loss function, Parameter Design, Robust Design; TPM- concepts, 5S, Kaizen, FMEA- stages, Zero Defect. B) TQM Implementation: Manufacturing and Service sectors, Introduction to Six Sigma: Definition, Concept, Methodology. Six Sigma Approaches – Design for Six Sigma (DFSS) Approach & DMAIC Approach, Six Sigma Tools: Applications to manufacturing and service sector including IT, ITeS, and E Com.	08
5	Quality Management System & Certification: A) QMS: Elements and documentation, Quality auditing, Necessity for Certification & Certification Process, Benefits of Certification. Certifying Bodies & Accreditation Agencies, ISO 9000-2015 (5th Edition), Introduction to TS16949: Technical Specifications, QS9000, ISO14000- concepts, requirements and benefits. Case studies of TQM implementation in manufacturing and service sectors including IT and Environmental management systems- ISO 14000 Series Standards, Integration of ISO 14000 with ISO 9000. B) Quality Awards: Malcom Baldrige National Quality Award and Rajiv Gandhi National Quality award.	06
6	Future Trends in TQM : Strategic approach to leadership , Customer centric endeavors , Involvement & empowerment of all employees / stake holders , Decision making based on real time facts , Win-Win policy with suppliers , New paradigms of Green & sustainability , TQM beyond Manufacturing i.e. Healthcare, Education, Finance. Accountability through new tools and technologies, Quality Analytics.	06

Text Books:

1. Besterfield D.H. et al.: Total quality Management, 3rd Edition, Pearson Education Asia, 2006.
2. Janakiraman B. and Gopal R.K.: Total Quality Management, Prentice Hall India, 2006.
3. Poornima M. Charantimath: Total Quality Management, 2nd Edition, Pearson Education Asia, 2006.
4. N. Logothetis: Managing for Total Quality, 6th Edition, Prentice Hall of India Pvt. Ltd. 2003.
5. Suganthi L. and Samuel A.: Total Quality Management, Prentice Hall India, 2006.
6. Evans J.R. and Lindsay W.M.: The Management and Control of Quality, 8th Edition, 1st Indian Edition, Cengage Learning, 2012.

Reference Books:

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.

Course Code	Course Name	Credits
ILO8021	Project Management	03

Objectives:

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

Outcomes: Learner will be able to...

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

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

05	5.1 Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings 5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit 5.3 Project Contracting Project procurement management, contracting and outsourcing,	8
06	6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects 6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

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

Course Code	Course Name	Credits
ILO 8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	Overview of Indian Financial System: Characteristics, Components and Functions of Financial System. Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09

04	Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

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

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs
- 4.

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

06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05
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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. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

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

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

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

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

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

Assessment:

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

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

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

Outcomes: Learner will be able to...

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

Module	Detailed Contents	Hrs
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design	08

	f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	04

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

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Objectives:

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

Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

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

06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07
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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. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,

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

Course Code	Course Name	Credits
ILO 8028	Digital Business Management	03

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure	06

4	Managing E-Business -Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	E-Business Strategy -E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization -Business plan preparation Case Studies and presentations	08

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. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan

- 8.** E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
- 9.** Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
- 10.** Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Objectives:

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

Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

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

Assessment:

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

Course Code	Course Name	Credits
MEL801	Product Design and Development	01

Objectives:

1. To familiarize concepts in PD&D for practical implementation
2. To acquaint with the applicability of PD&D in industrial applications

Outcomes: Learner will be able to...

1. Identify the need for developing products
2. Select suitable PD&D processes
3. apply the creativity & industrial design methods to design & develop the chosen product
4. Work collaboratively in a team to complete a PD&D project.
5. Effectively communicate the results of projects and other assignments both in a written and oral format.

Assignments:

Total 3 to 4 assignments have to be given.

Assignments III and IV are compulsory and shall be treated like mini-projects. Two more could be covered from the remaining as case studies.

I. Based on Module No. 1 and 2.

1. Select any one consumer product, such as
 - a) a mobile
 - b) a laptop
 - c) a pencil sharpener
 - d) a table and chair
 - e) a stool
 - f) a bicycle
 - g) a pen
 - h) a storage device of any household items
 - i) a cupboard etc..... anything

Assume that you want to go for re-development of any one of the products. How would you tackle by answering any 3 or 4 points that are given below? Q1. How do you identify the need for developing the product?

Q2. What are the changes that you would like to incorporate?

Q3. Would it be Engineering Design or Industrial design factors or both? Q4.

What are the generic PD&D processes that you would like to adopt? Q5. What are the methods that you would adopt for Market research?

Q6. If you would like to develop which design process you would like to adopt?

Q7. If you select descriptive design... then why? If you select prescriptive design... then why? Q8. What are the steps that you would like to adopt while developing the product?

II. Based on Module No. 3.

2. Select any one consumer product, such as

- a) a mobile
- b) a laptop
- c) a pencil sharpener
- d) a table and chair
- e) a stool
- f) a bicycle
- g) a pen
- h) a storage device of any household items
- i) a cupboard etc..... anything

Assume that you want to go for re-development of any one of the above products.

How would you tackle by answering any 3 or 4 points that are given below?

Q1. How do you identify the customer needs for developing the product?

Q2. How do you ascertain/select the attributes that are to be tackled?

Q3. Would you like to go for Engineering Design factors or Industrial design factors or both?

Q4. How do you develop a correlation matrix?

Q5. How do you “Construct House of Quality”?

Q6. What are the generic PD&D processes that you would like to adopt in re-designing it using House of quality?

Q7. What are the methods that you would adopt for Market acceptance? Q8.

How do you document the entire design process?

III. Based on Module No. 4.

3. Select any one consumer product, such as

- a) a mobile

- b) a laptop
- c) a pencil sharpener
- d) a table and chair
- e) a stool
- f) a bicycle
- g) a pen
- h) a storage device of any household items
- i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the creativity method to design the chosen product using any one creativity methods? Develop the product and document the entire process by answering some of the questions as shown in I or II.

IV. Based on Module No. 5.

4. Select any one consumer product, such as
 - a) a mobile
 - b) a laptop
 - c) a pencil sharpener
 - d) a table and chair
 - e) a stool
 - f) a bicycle
 - g) a pen
 - h) a storage device of any household items
 - i) a cupboard etc.... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the principles of Industrial Design methods to design the chosen product? Develop the product and document the entire process by answering some of the questions as shown in I or II.

V. Based on Module No. 6.

5. Select any one consumer product, such as
 - a) a mobile
 - b) a laptop

- c) a pencil sharpener
- d) a table and chair
- e) a stool
- f) a bicycle
- g) a pen
- h) a storage device of any household items
- i) a cupboard etc..... anything

Assume that you want to go for re-development of any one of the above products.

How would you apply the principles of DFMA to design the chosen product? Develop the exploded view of the product and document the entire process by answering some of the questions as shown in I or II.

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

Assignments/Case studies:10 marks. Mini

Project:10 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) Oral**10** marks

Evaluation of practical examination to be done based on the practical performed.

Students work along with evaluation reports to be preserved till the next examination.

Text/Reference Books:

1. Baker, M. & Hart S. (2007), Product Strategy and Management, (2nd. Ed.) Edinburgh: Pearson Education.
2. Ulrich, K. & Eppinger, S. (2012), Product Design and Development. (5th. Ed.) Los Angeles: McGraw Hill Education.
3. Yousef Haik, T. M. M. Shahin (2010), Engineering Design Process, (2nd. Ed. Reprint), Cengage Learning, ISBN 0495668141.
4. Kevin Otto, Kristin Wood (2004), Product Design, (Indian Reprint), Pearson Education, ISBN 9788177588217.

Course Code	Course Name	Credits
MEL802	Laboratory based on IoT	01

Objectives:

1. To learn microcontroller programming using 8051 and Arduino Development Board.
2. To acquaint with interfacing of simple peripheral devices to a microcontroller.
3. To acquaint with exchange of data using wireless communication.
4. To familiarize with logging the data on cloud platform.

Outcomes: Learner will able to...

1. Develop simple applications using microcontrollers 8051 and Arduino.
2. Interface simple peripheral devices to a Microcontroller.
3. Use microcontroller based embedded platforms in IoT.
4. Use wireless peripherals for exchange of data.
5. Setup cloud platform and log sensor data.

List of Experiments:

1. Interfacing experiments using 8051 Trainer kit and interfacing modules
 - a. display (LCD/LED/Seven Segment)
 - b. Stepper / DC Motor
2. Introduction to Arduino platform and programming
3. Simple Applications using Arduino Development Board (Any two)
 - a. Simple LED Blinking using development board
 - b. Building IOT Smart Switch using IOT
 - c. Pulse Width Modulation
 - d. Analog to Digital / Digital to Analog Conversion
4. Interfacing Arduino with a Sensor (Any one): Temperature Sensor / PIR/ Ultrasonic sensor/ IR Sensor/ Flame Sensor/ MQ6 Sensor/ Humidity sensor/ Raindrop Sensor, magnetometers, cameras, accelerometers etc.
5. Interfacing Arduino with an Actuator (Any One): Motors / solenoids / Controllers etc.
6. Communication using Wireless Medium (Any One): WiFi / Bluetooth / Zigbee / RFID etc.
7. Setting up and Cloud Platform and logging Sensor Data on the platform.

Assessment:

Term Work

Term work shall consist of the experiments as mentioned above.

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

1. Laboratory work (Experiments): 20 marks
2. Attendance: 05 marks

End Semester Practical/Oral Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral.

Course Code	Course Name	Credits
MEP801	Major Project II	12

Objectives::

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 to successful completion of the project by implementing the solution.

Outcomes: Learner will able to

- 1 Students will be able to implement solutions for the selected problem by applying technical and professional skills.
- 2 Students will be able to analyze impact of solutions in societal and environmental context for sustainable development.
- 3 Students will be able to collaborate best practices along with effective use of modern tools.
- 4 Students will be able to develop proficiency in oral and written communication with effective leadership and teamwork.
- 5 Students will be able to nurture professional and ethical behavior.
- 6 Students will be able to gain expertise that helps in building lifelong learning experience.

Guidelines:

1. 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.

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. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective

- Proposed System
 - Analysis/Framework/ Algorithm
 - Design details
 - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up
 - Details of Database or details about input to systems or selected data
 - Performance Evaluation Parameters (for Validation)
 - Software and Hardware Set up
- Results and Discussion
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

Desirable

- Students should be encouraged
 - to participate in various project competition.
 - to write minimum one technical paper & publish in good journal.
 - to participate in national / international conference.

3. Term Work:

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

- a. Weekly Log Report
- b. Completeness of the project and Project Work Contribution
- c. Project Report (Black Book) (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 2 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 following:

1. Relevance to the specialization / industrial trends
2. Modern tools used
3. Innovation
4. Quality of work and completeness of the project
5. Validation of results
6. Impact and business value
7. Quality of written and oral presentation
8. Individual as well as team work