D. Y. Patil College of Engineering and Technology

Kasaba Bawada, Kolhapur

(An Autonomous Institute)

Accredited by NAAC with 'A' Grade

B. Tech Programme Structure

B. Tech.

(Mechanical Engineering)

(To be implemented from academic year **2023-24)**

D Y Patil College of Engineering and Technology, Kasaba Bawada, Kolhapur
Department of Mechanical Engineering

Department of Mechanical Engineering
Final Year B.Tech. In Mechanical Engineering
Semester-VII

Sr. No	Course Code	Course Type	Name of the Course	Teaching Scheme Per Week			Credits	Total Marks	Evaluation scheme			
				Lecture	Tutorial	Practical			Type	Max. Marks	Min. Marks for Passing	
1	201MEL401	PCC	Refrigeration and Air Conditioning	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
2	201MEL402	PCC	Mechatronics	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
3	201MEL403-405	PEC	Professional Elective Course - I	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
4	201MEL406-407	OEC	Open Elective Course - II	3	1	-	4	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
5	201MEP401	LC	Refrigeration and Air Conditioning Lab	-	-	2	1	50	ISE	25	10	10
									ESE (POE)	25	10	10
6	201MEP402	LC	Mechatronics Lab	-	-	2	1	50	ISE	25	10	10
									ESE (OE)	25	10	10
7	201MEP403-405	LC	Professional Elective Course-I Lab	-	-	2	1	25	ISE	25	10	10
8	201MEP408	PROJ	Internship	-	1	-	4	100	ISE	100	40	40
9	201MEP409	PROJ	Project Phase-I	-	-	4	2	100	ISE	50	20	20
									ESE (OE)	50	20	20
10	201MEP410	MC	Intellectual Property Rights (IPR) and Research Publication	2	-	-	-	50	ESE	50	20	20
			Total	**14**	**2**	**10**	**22**	**775**	**Total Credits: 22**			
									Total Contact Hrs.: 26			

D Y Patil College of Engineering and Technology, Kasaba Bawada, Kolhapur
Department of Mechanical Engineering

Professional Elective Course -I

Sr. No	Course Code	Course No.	Professional Elective Course -I
1	PEC	201MEL403	Automobile Engineering
2	PEC	201MEL404	Supply Chain and Logistics Management
3	PEC	201MEL405	Robotics and Automation

Open Elective Course-II

Dept	Subject Name
CSE	i) Security and Privacy in Social Networks
	ii) Web Applications Development
ETC	i) Biomedical Instrumentation
	ii) Electronic Automation
Civil	i) GPS & Remote Sensing
	ii) Smart Cities
Chem	i) Fuel Cell Technology
	ii) Industrial Behaviour and Practices
DS	i) Business Intelligence & Analytics.
	ii) Data Visualization and Storytelling.
AIML	i) AI For Everyone
	ii) Machine Learning with Python
Arch	i) Affordable Housing
	ii) Sustainable Community Living

D Y Patil College of Engineering and Technology, Kasaba Bawada, Kolhapur
Department of Mechanical Engineering

Course Code	Definition
BSC	Basic Science Course
ESC	Engineering Science Course
HSMC	Humanity and Social Science including Management Course
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
LC	Laboratory Course
MC	Mandatory Course
PROJ	Project

Abbreviations:

ISE: In Semester Evaluation,
MSE:-Mid Semester Examination,
ESE: End Semester Examination

D Y Patil College of Engineering and Technology, Kasaba Bawada, Kolhapur
Department of Mechanical Engineering

Student can choose any one track for the **Semester-VIII** from the following –

1. Regular Academic Track –

- This is the regular academic track where lectures, practical and Project Phase –II work will be conducted regularly as per the time table in the department and college campus.
- Project Phase –II, consider the workload of 2 hours per week for each project group consisting of 5 students.

Department of Mechanical Engineering Final Year B.Tech. In Mechanical Engineering Semester-VIII												
Sr. No	**Course Code**	**Course Type**	**Name of the Course**	**Teaching Scheme Per Week**			**Credits**	**Total Marks**	**Evaluation scheme**			
				Lecture	**Tutorial**	**Practical**			**Type**	**Max. Marks**	**Min. Marks for Passing**	
11	201MEL411	PCC	Finite Element Analysis	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
12	201MEL412-414	PEC	Professional Elective Course- II	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
13	201MEL415-417	PEC	Professional Elective Course- III	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
14	201MEL418	PROJ	Project Phase –II	-	-	6	4	100	ISE	50	20	20
									ESE (OE)	50	20	20
15	201MEP411	LC	Finite Element Analysis Lab	-	-	2	1	50	ISE	25	10	10
									ESE (OE)	25	10	10
16	201MEP412-414	LC	Professional Elective Course - II Lab	-	-	2	1	25	ISE	25	10	10
17	201MEP415-417	LC	Professional Elective Course- III Lab	-	-	2	1	25	ISE	25	10	10
			Total	**09**	**0**	**12**	**16**	**500**	**Total Credits: 16**			
									Total Contact Hrs.: 21			

2. Professional Track –

D. Y. PATIL COLLEGE OF ENGINEERING & TECHNOLOGY, KOLHAPUR Teaching and Evaluation Scheme from Year 2023-24 Final Year B. Tech- Computer Science & Engineering SEMESTER-VIII –Professional Track													
Sr. No	**Course Code**	**Course Type**	**Name of the Course**	**Teaching Scheme per Week**				**Total Marks**	**Evaluation Scheme**				
				Lecture	**Tutorial**	**Practical**	**Credits**		**Type**	**Max. Marks**	**Min. for Passing**		
1	201MEP419	PROJ	Professional Skills Development **	-	1	20	3	100	ISE-I	100	80	160	
							3	100	ISE-II	100			
							6	200	ESE-OE	200	80		
2	201MEL420	PROJ	Project Phase –II	-	-	6	2	100	ISE	50	20	20	
							2		OE	50	20	20	
Total				-	1	26	16	500					200

Guidelines for Professional Track:

1. Student must submit his/her willingness for this track before the term end of semester – VII.
2. Head of the department will appoint one faculty coordinator to coordinate PTC work and manage all activities concerned with this track like assigning mentors to the students, organizing.

   Professional Track Committee (PTC) meetings, monitoring the entire process concerned with Professional Track, etc.
3. Student can apply the Professional Track in following scenarios provided he/she obtains a letter accordingly from the concerned authority while applying for this track –
   a. If student is selected in the company with PPO (Pre-Placement Offer) program through the college TPO.
   b. If student has an opportunity to work on the sponsored projects in industry/ResearchInstitute for a period of 3-5 months.
   c. If student is getting onsite Internship offer for a period of 3-5 months.
   d. If student is getting Company Training Program of 3-5 months (company must be quality standard certified for example ISO).
4. Students should submit the application along with all communication details to Professional Track faculty coordinator before the term end of semester – VII.
5. The work concerned with this track should be worth 400-500 hours and completed during semester-VIII.
6. All formalities of getting offer letter/permission of working in concerned organization (a-d) are to be completed from the concerned authority (a-d) in writing before starting of

ESE of Semester – VII.

7. Student should submit his/her application to the Professional Track Committee (PTC) along withdetails of communication done with the concerned authorities for its approval.
8. Professional Track Committee (PTC) comprises of HoD, Department T & P coordinator, T & P officer, faculty coordinator and two, third-party experts from Industry / Research Institute / Entrepreneur. The role of PTC is confined to assessment and approval of applications only.
9. Professional Track Committee (PTC) will assess the applications based on the communications, kind of work that is expected to be done by the student in concerned organization (a-d), allocation of concerned organization (a-d) supervisor, depth of the technical exposure, student's development and feasibility of work. Committee will accordingly approve application satisfying the guidelines for professional track and the decision of the committee will be final.
10. There should be a proper written communication between the concerned organisation, TPO, department T & P Coordinator and faculty coordinator mentioning the details clearly as per the syllabus structure.
11. Professional Track faculty coordinator should declare the list of students approved for, undertaking Professional Track before end of ESE of semester-VII.
12. It is mandatory for a student and his/her parent to submit an undertaking, mentioning completion of Professional Track as per concerned organisation requirements and guidelines as per syllabus structure.
13. If the student fails to complete above Professional Track as per the guidelines within the stipulated period of semester-VIII, he/she will be declared as FAIL. Such candidate has to complete the said work in subsequent 3-5 months period and then ESE-OE examination will be conducted during the regular examination schedule of the college.

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Following are the evaluation guidelines for Professional Skills Development Course -

i. The evaluation of the **Professional Skills Development** will be based on the work done by the student in concerned organisation.
ii. The faculty mentor assigned will be responsible for monitoring and assessment of the student on continuous basis.
iii. Every faculty mentor will be assigned workload of 1 hour per week for every student.
iv. The ISE marks are to be given based on the continuous assessment done by the concerned organisation (a-d) supervisor and faculty mentor.
v. Students must present their work to the faculty mentor every month in an online mode or onsite (Minimum 3 presentations) in coordination with concerned organisation (a-d) supervisor for 100 marks taken together for all presentations and demonstration under ISE -I with 3 credits.
vi. Concerned organisation (a-d) should provide certificate of completion of assigned task alongwith marks under ISE -II head for 200 marks with 6 credits, in coordination with the faculty mentor before the conduct of ESE-OE exam.
vii. ESE-OE is to be conducted for 200 marks with 7 credits in the concerned organisation (a-d) where the student is doing his/her work. The ESE-OE will be conducted by both, faculty mentor and concerned organisation (a-d) supervisor.
viii. Students should complete the **Professional Global Certification** either assigned by the

Industry Supervisor based on his assigned work or by faculty mentor. The certificate should be from renowned platform such as Swayam, Coursera etc. as per decision from Industrial supervisor or faculty mentor.

ix. All credits will be earned by the student on completion of ISE and ESE-OE.

Professional Elective Course -II

Sr. No	Course Code	Course No.	Professional Elective Course -II
1	PEC	201MEL412	Lean Manufacturing
2	PEC	201MEL413	Noise and Vibration
3	PEC	201MEL414	Energy and Power Engineering

Professional Elective Course -III

Sr. No	Course Code	Course No.	Professional Elective Course -III
1	PEC	201MEL415	Additive Manufacturing
2	PEC	201MEL416	Industrial Engineering
3	PEC	201MEL417	Industry 4.0

Course Code	Definition
BSC	Basic Science Course
ESC	Engineering Science Course
HSMC	Humanity and Social Science including Management Course
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
LC	Laboratory Course
MC	Mandatory Course
PROJ	Project

Abbreviations:

ISE: In Semester Evaluation, MSE:Mid Semester Examination,ESE: End Semester Examination

Program Coordinator **H.o.D.**

REFRIGERATION AND AIR CONDITIONING

COURSE CODE: 201MEL401

Course Plan

Course Title : **REFRIGERATION AND AIR CONDITIONING**	
Course Code : 201MEL401	**Semester: VII**
Teaching Scheme: L-T-P : **3-0-0**	Credits: **3**
Evaluation Scheme: ISE + MSE Marks : **20 + 30**	ESE Marks: **50**

Prerequisite: Applied thermodynamics, Heat Transfer,

Course Description:

This subject enables the student to understand Basic of Refrigeration system, Refrigeration Cycles, their analysis and performance evaluation. Students will also learn different refrigerants, their properties and various parts of Vapor compression cycle. Understand the working principles & concept of Psychometric and Human Comfort. To understand Basic of Heating and Cooling Load Calculation & Air Distribution System

Course Objectives:

1. To understand basics of refrigeration systems, Refrigeration Cycles,
2. To evaluate refrigeration systems under different conditions.
3. To understand the properties of refrigerants, & various parts of Vapor compression cycle
4. To understand concept of Psychrometry and Human Comfort
5. To understand & evaluate Heating and Cooling Load Calculation & Air Distribution System

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO401.1	Understand basics of Refrigeration system, Refrigeration Cycles.	L2
CO401.2	Analyze refrigeration systems under different conditions.	L3
CO401.3	Explain the properties of refrigerants & various parts of vapor compression cycle.	L2

CO401.4	Illustrate the concept of Psychrometry and Human Comfort.	L3
CO401.5	Evaluate Heating and Cooling Load Calculation.	L3
CO401.6	Interpret Air Distribution System.	L3

Course Content

Unit-1 **Basic of Thermodynamics & vapor compression cycle** Basic of A Refrigerating Machine – The Second Law Interpretation, Introduction to Heat pump, Heat Engine and Refrigerator (with Numerical treatment), Energy Ratios (EER), BEE star rating COP, Power Consumption of a Refrigerating Machine, Refrigeration Cycle, Vapor as a Refrigerant Reversed Carnot Cycle Limitations of Carnot Cycle with Gas as a Refrigerant, Reversed Brayton or Joule or Bell Coleman Cycle,	7.00 hrs
Unit-2 **Vapour Compression System** Limitations of Reversed Carnot Cycle with vapour as a Refrigerant, Dry versus Wet Compression, Throttling versus Isentropic Expansion, Introduction to Vapour Compression Cycle and Vapour Absorption cycle. Pressure Enthalpy Diagram and Calculations (Numerical on VCR Cycle) and effect of Operating Conditions, effect of Evaporator Pressure Effect of Condenser Pressure, effect of Suction Vapour Superheat, effect of Liquid Sub cooling, Using Liquid- Vapour Regenerative Heat Exchanger, Actual Vapour Compression Cycle. Removal of flash gas, Flash intercooling, Introduction to cryogenic Engineering and applications,	8.00 hrs
Unit-3 **Refrigerants and Refrigeration Equipment** Classification, Desirable Properties like Thermodynamic, physical, and chemical. Comparison among commonly used refrigerants, Selection of Refrigerants, Effect on Ozone depletion and global warming, Alternative Refrigerants. Environmental Protection protocol and India's commitment. Introduction to role of ASHRAE &ISHRAE in refrigeration and air conditioning area, ASHRAE Nomenclature. Insulation, types and different applications, properties of ideal insulations. Introduction to Equipment such as Compressor, Condenser, Evaporator, Expansion devices.	8.00 hrs.
Unit-4 **Psychrometry and Human Comfort** Moist air as a working substance, Psychrometric properties of air, Use of Psychrometric tables and charts, Processes, Combinations and Calculations (Numerical on Psychrometry), ADP, Coil Condition lime, Sensible heat factor, Bypass factor, Air washer and its applications. Thermal exchange between human body and environment, factors affecting comfort, effective temperature comfort chart, ventilation requirements	7.00 hrs
Unit-5 **Heating and Cooling Load Calculation:**	8.00 hrs

Representation of actual air conditioning process by layouts and on Psychometric charts, load analysis, RSHF, GSHF, ESHF, Enumeration and brief explanation of the factors forming the load on refrigeration and air conditioning systems, Energy requirements of different types of air conditioning systems, Energy conservation in air conditioning. Inside and Outside Design condition. Cooling Load estimation Introduction to Inverter technology and its use in power failure, Introduction to Phase change material used for temperature retention in refrigerator	
Unit-6 **Air Distribution System** Re-circulated air, Ventilation air, Duct work, Use of friction loss and rectangular equivalent of round duct chart, duct system, principle of duct sizing, and air distribution it's norms, diffusers, dampers, layout, duct systems for theaters, auditorium, hospitals, assembly shop etc. Energy Conservations and Green Buildings, Freeze drying, Pharmaceutical and hospital air conditioning, textile, car air conditioning (plant layout, system components and design conditioning	7.00 hrs

Textbook:

1. "Refrigeration and Air Conditioning",C. P. Arora, Tata McGraw-Hill Publishing Company Ltd., New Delhi,1981,2ndEdition.
2. "Refrigeration and Air Conditioning", by Er. R. K. Rajput.(3 rd Edition,Katsonbook.)
3. Dr. S.N. Sapali "Refrigeration and Air-conditioning", PHI (Second Edition) 2011.

Reference Books:

1. "Basic Refrigeration And Air Conditioning", PN Ananthanarayan Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition,(1981).
2. "Refrigeration and Air Conditioning", Arora Domkundwar, Pearson Education,3 rd Edition.
3. "Refrigeration and Air Conditioning", Stoker.
4. Roy J. Dossat "Principles of Refrigeration", Pearson, fourth edition, 2007.

MECHATRONICS
COURSE CODE: -201MEL402

Course Plan

Course Title: Mechatronics	
Course Code: **201MEL402**	**Semester: VII**
Teaching Scheme: L-T-P : **3-0-0**	Credits: **3**
Evaluation Scheme: ISE + MSE Marks: **20+30**	ESE Marks: **50**

Prerequisite: Essentials of Electrical & Electronics Technology.

Course Description:

Mechatronics course is of importance due to the global demand and developments in Mechatronics system, Industrial Automation & Robotics, Industry 4.0 automated manufacturing systems, planning and controlling activities etc. For designing and developing mechatronics systems students of mechanical engineering must understand basic elements of mechatronics systems such as sensors, microcontrollers, microprocessors, logic and programs for automating the processes.

Course objective: -

1) To prepare Mechanical Engineering students for advanced graduate studies in Mechatronics, Manufacturing engineering, Industrial automation and related field
2) To introduce graduate of mechanical engineering with working principle of Microprocessor and Microcontroller
3) To provide the fundamentals of PLC programming, ladder diagram and significance of PLC systems in industrial application
4) Understand working principle of Arduino

Course Outcome (CO): -

At the end of the course the student should be able to:

CO	Statement	BTL
CO402.1	Explain the construction, working principals and functions of input, processors and output components used in the mechatronics system.	L2
CO402.2	Understand the principle of Microprocessor and Microcontroller	L2
CO402.3	Understand the fundamentals of PLC programming, Ladder diagram and its significance in industrial application	L3
CO402.4	Write the simple PLC programming by using Timer and Counter	L2

CO402.5	Solve a PLC ladder diagram for different application	L3
CO402.6	Explain the construction, working principals of Arduino	L2

Course Content

Unit 1: Introduction to Mechatronics Introduction to Mechatronics, Mechatronics systems, multi discipline scenario Transducers & Sensors, Position Sensors: Limit switch, photoelectric switches, proximity sensors, incremental & absolute encoders, decoders & relays. Displacement: Potentiometer sensors, capacitive displacement sensors. Velocity sensors: Tachogenerator, use of encoders, advances in sensors.	6.00 hrs
Unit 2: Digital circuits, Microprocessor and Microcontroller Introduction to Digital logic gates, Boolean algebra, application of logic gates, Combinational and sequential logic, flip flop, D flip flop, JK flip flop, Master slave flip flop. Comparison between microprocessor and micro controller, organization of a microprocessor and microcontroller system, architecture of PIC controller, instruction types and set,	8.00 hrs
Unit 3:Introduction to PLC Introduction, definition, PLC system and components of PLC input output module, PLC advantages and disadvantages. Ladder diagram & PLC programming fundamentals, machine control terminology, update – solve ladder – update, physical components Vs. program components	6.00 hrs
Unit 4:Applications of PLC Internal relays, light control example, disagreement circuit, majority circuit, holding (sealed or latches) contacts, always ON always OFF contacts, fail safe circuits, PLC timer and counter functions with an examples Introduction and types. Introduction Human machine Interface (HMI), Difference between HMI and PLC, Introduction to SCADA & its Industrial application	8.00 hrs
Unit 5: Industrial applications – Automatic liquid filling system, liquid mixture, traffic control light, pick & place robot, washing machine, vending machine, sorting machine, conveyor system, robotic arm, water heating,	9.00 hrs
Unit 6: Introduction to Arduino What is Arduino, Arduino Family-Uno, Nano, Mega etc. Arduino Architecture, Arduino Pinout and pin designations- analog i/o, digital i/o, pwm, serial communication, i2c, advantages, disadvantages and applications of Arduino **Introduction to Arduino IDE** What is Arduino IDE, installation, introduction to work environment, introduction to boards manager, library manager, example sketches etc.	8.00 hrs

Textbook

1 “Mechatronics”, W. Bolton, Pearson Education , 4th Edition,

2 “Mechatronics: Principles & applications”, Godfrey Onwubolu Elsevier (2005)

3 “Microprocessor 8085”, Gaokar Prentice Hall of India, 5th Edition ,

4 “Introduction to PLC Programming” NIIT.

5 “Programmable Logical Controller”, Hackworth, Pearson Education, (2008).

6 “Programmable Logical Controller”, Reis Webb, Prentice Hall of India 5th Edition.

Reference Books:

1 “Introduction to Mechatronics” AppuKuttam, Oxford Publications, 1st Edition.

2 Introduction to Mechatronics & Measurment Systems”, David G AlciatoreMichel Histand, Tata McGraw Hill Pub. Co.New Delhi 4th Edition

3 “Automated Manufacturing Systems” ,S. Brain Morris, Tata McGraw Hill

4 “Mechatronics and Microprocessor”, Ramchandran , Willey India, (2009).

5 “Mechatronics: Integrated Mechanical Electronic System”, Ramchandran , Willey India,1stEdition.

6 “Programmable Logical Controller”Gary Dunning Cengage Learning, 3rd Edition.

Online Resources:-

1. https://nptel.ac.in/courses/112107298
2. https://nptel.ac.in/courses/112103174

PROFESSIONAL ELECTIVE COURSE -I
AUTOMOBILE ENGINEERING

COURSE CODE: 201MEL403

Course Plan

Course Title : **Automobile Engineering**	
Course Code : **201MEL403**	**Semester : VII**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Basic Mechanical Engineering, I. C Engines.

Course Description:

The aim of course is to understand the working of different automobile system. In this course the students will be familiar with advances in automobile. The focus of the course will be demonstration of working models of automobile systems and analyze automobile performance at different operating conditions.

Course Objectives:

1. To make students familiar with various basic systems of automobile.
2. To introduce the mathematical treatments required for vehicle performance.
3. To make students aware about latest trends in transportation towards a safe, pollution free and fully automatic vehicle.
4. To empower students to face the real life automotive usage with greater confidence

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO403.1	Understand basic concepts of automobile engineering.	L2
CO403.2	Learn the ability to understand deferent automobile systems and components.	L2
CO403.3	Identify, formulate and solve automobile engineering problems.	L3
CO403.4	Function on automobile engineering laboratory teams.	L3

Course Content

Content	Hours
Unit No. 01: Introduction Automobile history and development, Classification, vehicle layouts- engine location and drive arrangement, specifications of vehicles, Type of vehicle bodies, body parts and its advanced materials, Chassis types, constructional details, details of chassis material, Types of frames, sub-frames, frameless vehicles.	5.00 hrs
Unit No. 02: Transmission System **Clutch** – Function and requirements, Classification, Construction and working of Single-plate, Multi-plate, Diaphragm spring and centrifugal clutches, Fluid flywheel. **Gear Box** – Necessity, classification, construction of manual gear boxes like Sliding mesh, constant mesh, Synchromesh, Epicyclic gear train, Automatic transmission, CVT, Overdrive. Propeller shaft, Differential and final drive	8.00 hrs
Unit No. 03: Steering and Braking Systems **Steering systems**- function, principle of steering, Ackerman and Davis, steering geometry, center point steering, cornering force, slip angle, scrub radius, steering characteristic, Types of steering gearbox, power steering, collapsible steering. **Braking system**- Need, principle, types, Mechanical, hydraulic and pneumatic brakes, disc and drum types, air brakes, Anti-lock braking system, Brake adjustments, defects and causes.	7.00 hrs
Unit No. 04: Suspension and Electrical system **Suspension system**- Functions, Types of suspension linkages, types of spring - leaf, coil, air springs, telescopic shock absorber, hydro gas suspension, rubber suspension, self-leveling suspension (active suspension), Air suspension, Advances in suspension system. **Electrical system**-Automotive batteries, battery charging system, alternators, starter motor, Bendix drive, Modern automobile batteries, Advance ignition systems, lighting and electrical accessories, automobile air conditioning, panel board instruments.	8.00 hrs
Unit No. 05: Vehicle Performance Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Gradeability and draw bar pull, Traction and Tractive effort, Distribution of weight, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio. (Numerical treatment)	7.00 hrs

Unit No. 06: Recent Trends in Automobiles Construction & working of different types of sensors used in automobiles, Safety in Automobiles, Hybrid vehicles, Fuel Cell, Electrical vehicles, Autonomous Vehicles.	5.00 hrs

Textbook:

1. Kripal Singh, Automobile Engineering Vol II, Standard Publishers Distributors, Tenth Edition , 2007
2. P S Gill, Automobile Engineering II, S K Kataria and Sons, Second Edition, 2012
3. R K Rajput, Automobile Engineering, Laxmi Publications, First Edition, 2007
4. Automobile Engineering", G.B.S. Narang., Khanna Publication, 3rdEdition.

Reference Books:

1. Newton, Steeds and Garrett, The Motor Vehicle, Butterworths International Edition, 11th Edition, 1989
2. Crouse and Anglin, Automotive Mechanics, McGrawhill Publication, Tenth Edition, 2007
3. William Crouse, "Automobile Engineering"

PROFESSIONAL ELECTIVE COURSE -I
SUPPLY CHAIN AND LOGISTICS MANAGEMENT
COURSE CODE: 201MEL404

Course Plan

Course Title: **SUPPLY CHAIN LOGISTICS MANAGEMENT**	
Course Code: **201MEL404**	**Semester: VII**
Teaching Scheme: L-T-P: 3-**0-0**	Credits: 3
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks: **50**

Prerequisite: Industrial Management and Operational Research

Course Description:

There is a great deal of confusion regarding exactly what Supply Chain Management involves. In fact, most people using the name Supply Chain Management treat it as a synonym for logistics or as logistics that includes customers and suppliers. However, successful SCM requires cross functional integration of key business processes within the firm and across the network of firms that comprise the supply chain. This course introduces the concepts of Logistics and Supply Chain Management. It also provides an understanding of Logistics while underlining the importance of Supply Chain Management in different kinds of Industries. This course provides an integrated view of purchasing, production, inventory, transportation, warehousing and administration.

Course Objectives:

1. An understanding of the primary differences between logistics and Supply Chain Management
2. An understanding of the individual processes of Supply Chain Management and their interrelationships within individual companies and across the supply chain
3. An understanding of the management components of Supply Chain Management
4. An understanding of the tools and techniques useful in implementing Supply Chain Management
5. Knowledge about the professional opportunities in Supply Chain Management.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	**Understand about the concepts of SCM and logistics management.**	**BTL**
CO404.1	Identify different kinds of supply chain relationship operations associated with the business organizations for maintaining effective supply chain relations.	L2
CO404.2	Organize the sourcing and transporting decisions for the propose minimizing the transporting cost and cost of purchase.	L2
CO404.3	Create awareness of warehouse, packaging and material handling decisions in Supply Chain Management.	L2
CO404.4	Design transportation network & analyze factors affecting transportation decisions.	L3
CO404.5	Understand the relationship development management and explore operational, social and financial performance.	L2

Course Content

Textbook:	Content	Hours
	Unit 1: 21st Century Supply Chains: Introduction and Concepts, Generalized Supply Chain Model, Financial Sophistication, Logistics Value Proposition, the Work of Logistics, Logistical Operations, Logistical Operating Arrangements, Flexible Structure, Supply Chain Synchronization.	04.00 hrs
	Unit 2: Customer Accommodation: Customer-focused Marketing, Customer Service, Customer Satisfaction, Customer Success, Forecasting, CPFR, Procurement and Manufacturing. **Information Technology Framework:** Comprehensive Information System Integration, Communication Technology, Rationale for ERP Implementation, ERP System Design, SC Information System Design.	09.00 hrs
	Unit 3: Inventory: Functionality and Definitions, Inventory Carrying Cost, Planning Inventory, Managing Uncertainly, Inventory Management Policies and Practices. **Transportation:** Transportation Infrastructure; Transport Functionality, Principles & Participants, Regulations, Transport Structure, Transport Service, Transport Operations; Transport Economics and Pricing, Transportation Administration, Documentation.	09.00 hrs
	Unit 4: Warehousing: Strategic Warehousing, Warehouse Operations, Ownership arrangements, Warehouse Decisions, Warehouse Management Systems. **Packaging and Material Handling:** Packaging Perspectives, Packaging for Material Handling Efficiency, Materials Handling, Supply Chain Logistics Design: Global Strategic Positioning; Global SC Integration, SC Security, International Sourcing.	09.00 hrs
	Unit 5: Network Integration: Enterprise Facility Network, Warehouse Requirements, Total Cost Integration, Formulating Logistical Strategy. **Logistics Design and Operational Planning:** Planning Methodology Phase-I, II and III, SC Analysis Methods and Techniques.	09.00 hrs
	Unit 6: Supply Chain Logistics Administration: Relationship Development and Management, Operational, Financial and Social Performance.	04.00 hrs

1. "Supply Chain Management -Strategy, Planning & Operation" by Sunil Chopra & Peter Mcindl, Pearson Education Inc, 11th Edition, 2003.

2. "Logistics and Supply Chain Management" by K. Shridhara Bhat, Himalaya Publishing House, 1st Edition, 2016.

Reference Books:

1. Supply Chain Management by Rahul V Altekar, PHI Learning Ltd, New Delhi, 2009.
2. "Strategic Logistics Management" by Douglas Lanibert & James Stock, McGraw Hill, 4th Edition, 2004.

PROFESSIONAL ELECTIVE COURSE -I
ROBOTICS AND AUTOMATION
COURSE CODE: 201MEL404

Course Plan

Course Title : **Robotics and Automation**	
Course Code : 201MEL405	**Semester :VII**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Essentials of Electrical and Electronics Technology

Course Description:

The course "Robotics and Automation" provides a comprehensive understanding of robotics and automation in Mechanical Engineering. Students explore robot kinematics, control systems, sensors, actuators, and end effectors. They learn robot programming, machine vision, industrial automation, and SCADA

Course Objectives:

1. To provide fundamental concepts and principles of robotics and automation.
2. To gain knowledge of robot kinematics, dynamics, control systems, and sensor-actuator systems.
3. To develop proficiency in robot programming, machine vision, and industrial automation.
4. To make students aware of Industrial Automation Scenario, development and implementation of SCADA system

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO405.1	Understand basics of Robotics with their classification and anatomy	L2
CO405.2	Understand robot kinematic and dynamics parameters to design a robot	L2
CO405.3	Select appropriate sensors, actuators and end effectors for robotic application	L
CO405.4	Select suitable control system and controller for robot	L3
CO405.5	Generate program for Robotic control as well as implementation of machine vision system in robotics	L3
CO405.6	Develop SCADA System simulation for any Industrial automation scenario	L4

Course Content

Content	Hours
Unit 1: Introduction to Robotics Brief History, Basic Concepts of Robotics such as Definition, three laws, Robot anatomy, DOF, Misunderstood devices etc., Evolution of Robots, Classification of Robotic systems, Related parameters i.e. resolution, accuracy, repeatability, etc, Industrial applications of robot. Robot Components and their Characteristics. - Collaborative Robots (Cobots): Introduction, Types, applications, Programming, Human-robot collaboration and safety	08.00 hrs
Unit 2: Robot Kinematics and Dynamics Robot Classification based on Kinematics, Different Types of Robot Joints, various drive Mechanisms used in robotics, Direct Kinematics and Inverse Kinematics, Homogeneous Transformations, Denavit-Hartenberg Convention, Robot Dynamics Robot Motion Planning, Robot Trajectory Control	09.00 hrs
Unit 3: Robot Sensors, Actuators and End Effectors. **Sensors** – Introduction, Classifications of sensors according to Sensing entity, operating parameters, output signals etc., Contact, Non-Contact sensors. Selection criteria for sensors. **Drive**s - Types of Drives, Types of transmission systems, **Actuators** – Hydraulic Actuators, Pneumatic Actuators, selection of Actuators while designing a robot system. Motors – DC Motors, Servo Motors, Stepper motors etc.	06.00 hrs
Unit 4: Control for Robotics Control Systems: introduction to Open loop and Closed loop control systems, Types of Controllers, PID Controller, Control Systems in Robotics- Continuous, discrete, adaptive, Robust control systems etc. NC Controller- Introduction, Types, applications, advantages, disadvantages and Selection	05.00 hrs
Unit 5: Robot Programming and Machine Vision: Robot Programming: Introduction, programming methods, various programming languages. Robot Simulation: Robot simulation, Simulation software such as RoboDK, RoboStudio, RoboGuide, etc. Machine Vision: Introduction, fundamental concepts, Image processing techniques, integration of vision systems in robotics.	08.00 hrs
Unit 6: Industrial Automation and SCADA: Industrial Automation: Introduction, Automation System Configurations, Automated Production and Assembly systems. SCADA: Introduction and System Design, Various Software Used for SCADA system, System Simulation using SCADA Software, Ethical and Social Considerations in Robotics and Automation	09.00 hrs

Textbook:

1. "Introduction to Robotics" 2nd edition, S. K. Saha, TATA McGraw Hills Education (2014)
2. "Robotics: Fundamental concepts and analysis", Asitava Ghoshal, Oxford University Press (2006

Reference Books:

1. "Fundamentals of Robotics", Dilip Kumar Pratihar, Narosa Publishing House, (2019)
2. "Robotics and Control", R. K. Mittal, I. J. Nagrath, , TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
3. "Introduction to Robotics – Analysis, Control, Applications", S. B. Niku, John Wiley & Sons Ltd., (2020)
4. "Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms", J. Angeles, Springer (1997)
5. "Industrial Robotics 2nd edition", Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, SIE, McGraw Hill Education (India) Pvt Ltd (2012)

Online sources:

1. https://nptel.ac.in/courses/107106090
2. https://nptel.ac.in/courses/108108147

OPEN ELECTIVE COURSE II

INDUSTRIAL MANAGEMENT

COURSE CODE: 201MEL406

Course Plan

Course Title : **Industrial Management**	
Course Code : 201MEL406	**Semester :VIII**
Teaching Scheme : L-T-P : **3-1-0**	Credits : **4**
Evaluation Scheme : ISE + MSE Marks : 20+30	ESE Marks : **50**

Prerequisite: Basic knowledge of industrial terminologies in relative industries *viz.* mechanical, electronics, chemical, computer etc.

Course Description:

This course provides an overview of management principles and techniques in industrial settings. Students will learn about planning, organizing, leading, and controlling industrial operations, as well as concept of marketing management and production management. The course will also cover topics related financial and cost management aspects. Through case studies, students will get knowledge about starting of SSI and project report writing.

Course Objectives:

1 To understand various functions of management.

2 To know Production and marketing functional area of management.

3 To get knowledge about how to start SSI.

4 To understand financial management and cost related aspects

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO406.1	Understand the concept and principles of management	L2
CO406.2	Apply the planning, organizing, staffing, directing, and controlling functions of management in given situation.	L3
CO406.3	Judge the problems related to production management and marketing management	L4
CO406.4	Understand the steps involved in starting a small-scale industry	L2
CO406.5	Implement knowledge of financial management and cost accounting in given situation.	L3
CO406.6	Discuss modern concepts in management	L2

Course Content

Content	Hours
Unit 1 : Basics of Management Definition Of Management, Characteristics Of Management, Managerial Skills, Different Levels of Management, Structure , Function of management , Scientific Management- Contribution of F.W.Taylor, Henry Fayol, Henry-Fayol's, Forms Of Ownerships – Partnership, Proprietorship, Joint Stock, Co-Operative Society, Govt. Sector Etc, Concept Of Globalization	8.00 hrs
Unit 2 : Function of management *Planning* –Objectives, Steps in Planning, elements of planning, *Organizing* – Process of Organizing, importance and principle of organizing, depart mentation, Span of control. *Staffing* – Nature, Purpose, Scope, Human resource management, Policies, Recruitment procedure, training and development, appraisal methods. *Directing* – Leadership style, Communication process, Barriers, remedies, Motivation, importance Herzberg's theory, Maslow's theory, McGregor's theory . *Controlling*–Process, Requirement for control management	8.00 hrs
Unit 3 : Functional Areas of Management Production Management-Product mix, line balancing, break even analysis, Total Productive Maintenance, Problem solving Techniques. Marketing Management –Principles & Functions, Types of Market, Market Research, Market Segmentation, Marketing Mix, Advertisement, Channel Of Distribution.	7.00 hrs
Unit 4 : SSI & Entrepreneurship Development Types of small scale industries (SSI), Steps involved in starting SSI, Registration Procedure for SSI, Financial Assistance, , Government policies for SSI, Problems of SSI, Project Report writing, Industrial Safety, Concept of Entrepreneurship, Required Qualities of Good Entrepreneur , Failure of Entrepreneur	8.00 hrs
Unit 5 : Financial Management and Cost Accounting Types of Capital, Sources of Finance, Concept of Reserves and Surplus, Introduction and necessity of Financial accounting and Book Keeping, Terms used in Book keeping, Types of Assets & Liabilities. Introduction to GST and types of GST Importance and necessity of Cost Accounting, Elements of Cost, Prime Cost, Overheads, Factory Cost, Total Cost, Selling Price, Nature of Cost, Process Cost and Production cost (simple numerical), Controlling of Material Cost , Overhead, Labor cost.	8.00 hrs
Unit 6 : Modern Concepts in Management Management by Objectives (MBO), Management by Exception (MBE), SWOT Analysis – Business Process Re-engineering (BPR) , Management Information System (MIS)	6.00 hrs

Textbook:

1 "Industrial Engineering and Management", by O. P. Khanna, Dhanpatrai publications Ltd,

New Delhi.

2. "Industrial Management and Operation Research", NandkumarHukeri, Electrotech Publication.

Reference Books:

1. "Essentials of Management", Koontz and H.Weinrich, Tata McGraw Hill Publication, 12th Edition.
2. "Management, Today – Principles and Practice", Gene Burton and Manab Thakur, Tata McGraw Hill Publishing Company, New Delhi.
3. "Business Management", J.P.Bose, S. Talukdar, New Central Agencies (P) Ltd.,
4. "Production and Operation Management", Tripathy, Scitech Publication, 2nd Edition.
5. "Management", James A.F. Stoner, R. Edward Freeman, Prentice Hall of India New Delhi.

Online Resources:

1. https://archive.nptel.ac.in/courses/110/105/110105094/
2. https://archive.nptel.ac.in/courses/110/101/110101132/
3. https://onlinecourses.nptel.ac.in/noc23_mg33/preview
4. https://archive.nptel.ac.in/courses/127/105/127105007/
5. https://onlinecourses.nptel.ac.in/noc21_mg70/preview

OPEN ELECTIVE COURSE II
COMPUTER INTEGRATED MANUFACTURING SYSTEMS
COURSE CODE: 201MEL407

Course Plan

Course Title : **Computer Integrated Manufacturing Systems**	
Course Code : **201MEL407**	**Semester : VII**
Teaching Scheme : L-T-P : **3-1-0**	Credits : **4**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Basic Mechanical Engineering, Basic Computer Science and Engineering.

Course Description:

Computer-integrated manufacturing system (CIMS) is the manufacturing approach of using computers to control the entire production process. Computer Integrated Manufacturing, known as CIM, is the phrase used to describe the complete automation of a manufacturing plant, with all processes functioning under computer control and digital information tying them together. This is the complete automation of a manufacturing facility such as a factory. All functions are under computer control. This starts with computer-aided design, followed by computer-aided manufacture, inspection followed by automated storage and distribution.

Course Objectives:

1. Elaborate the principle/s of Automation, CIM, CAD, CAM and study the differences between these concepts.
2. To acquaint student with the use computerized manufacturing planning and control system.
3. Study the fundamentals of Group technology, flexible manufacturing system.
4. Study application of robotics technology in the field of manufacturing and inspection.
5. Understand modern trends in Manufacturing like Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO407.1	Able to define Automation, CIM, CAD, CAM and explain the differences between these concepts.	L2
CO407.2	Discuss different computerized manufacturing Planning and control systems used in Industry and understand their output and benefits.	L2
CO407.3	Understand fundamentals of Group Technology and Flexible Manufacturing Systems	L2
CO407.4	Recognize applications of robotics in the field of manufacturing.	L2
CO407.5	Explain recent trends in manufacturing -Additive & Hybrid manufacturing	L2
CO407.6	Visualize and appreciate the modern trends in Manufacturing like Industry 4.0 and applications of Internet of Things leading to Smart Manufacturing.	L2

Course Content

Unit No. 01: Introduction to CIM and Automation. Meaning, Scope, Evolution, Architecture, Elements, Benefits, Limitations, traditional product cycle diagram, disadvantages and limitation of traditional product cycle, current production needs-production, accuracy, quality, repeatability, flexibility, survival etc. Role of Computers in design and manufacturing, integration. Automation in Production Systems, automated manufacturing systems- types of automation, reasons for automating etc.	7.00 hrs
Unit No. 02: Computerized Manufacture Planning and Control System: Computer Aided Process Planning, Retrieval and Generative Systems, benefits of CAPP, Production Planning and Control Systems, typical activities of PPC System, computer integrated production management system, Material Requirement Planning, inputs to MRP system, working of MRP, outputs and benefits, Capacity Planning, Computer Aided Quality Control, Shop floor control.	8.00 hrs
Unit No. 03: Flexible Manufacturing Systems: Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.	8.00 hrs
Unit No. 04: Robot Technology: Brief History, Basic Concepts of Robotics such as Definition, three laws, Robot anatomy, DOF, Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics. Types of robots. Application of Robots in various stages of manufacturing and inspection.	7.00 hrs
Unit No. 05: Additive Manufacturing Systems: Recent trends in manufacturing, Introduction to Additive manufacturing, Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies.	7.00 hrs
Unit No. 06: Future of Automated Factory: Industry 4.0, functions, applications and benefits. Components of Industry 4.0, barriers of implementation of I.4.0, Current scenario of industry 4.0 in India. Internet of Things (IOT), IOT applications in manufacturing, Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems.	8.00 hrs

Textbook:

1. CAD/CAM Principles and Applications, P N Rao, McGraw Hill Education.
2. CAD/CAM/CIM, P. Radhakrishnan, S. Subramanyan, V. Raju, New Age International Publishers.

Reference Books:

1. Automation, Production Systems, and Computer Aided Manufacturing, Mikell P. Groover, Prentice-Hall International publication.
2. Industrial Robotics, Groover, McGraw Hill Education.
3. Mechatronics, HMT limited, McGraw Hill Education
4. Principles of computer integrated manufacturing, Kant.S.,PHI Learning,New Delhi,(1995),ISBN10:812031476X.
5. CIM: Principles of computer-integrated manufacturing, Waldner.J.B., John Wiley & Sons Inc.UK,(1992),IBSN-9780471934509

Online Resources:

1. http://nptel.ac.in/courses/112102103/17
2. http://nptel.ac.in/courses/112107077/module5/1ecture2/lecture2.pdf
3. https://nptel.ac.in/courses/112103174/module1/lec2/3.html
4. https://3dp-dei.vlabs.ac.in/exp/simulation-anatomy-fdm/
5. https://3dp-dei.vlabs.ac.in/exp/simulation-anatomy-fdm/
6. https://3dp-dei.vlabs.ac.in/exp/simulation-anatomy-fdm/

REFRIGERATION AND AIR CONDITIONING LAB

COURSE CODE: 201MEP401

Course Plan

Course Title : **REFRIGERATION AND AIR CONDITIONING**	
Course Code : 201MEP401	**Semester : VII**
Teaching Scheme : L-T-P : 0-**0**-**2**	Credits : **1**
ISE: 25	ESE(POE)Marks :**25**

Prerequisite: Applied thermodynamics. Heat Transfer

Course Description:

The course deals with various experiments related to vapour compression cycle, vapor absorption cycle, Heat pump and Ice plant so as to understand the fundamentals and application refrigeration system. Also, Air condition to understand the concept and application of Air condition system

Course Objectives:

1: To provide the students the fundamentals of refrigeration and air conditioning system
2: To train students with good scientific and engineering breadth in the areas of refrigeration and air conditioning system, so as to comprehend, analyze, design and create novel products and solutions for the real-life problems

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO401.1	Demonstrate the working of vapor compression system and air conditioning system,.	**L2**
CO401.2	Estimate and analyze the cooling capacity, COP, Power of a VCR system..	**L4**
CO401.3	Estimate and analyze the cooling capacity, COP, Power of a heat pump	**L4**
CO401.4	Evaluate Vapor Absorption Refrigeration system.	**L3**
CO401.5	Evaluate the Ice plant.	**L3**
CO401.6	Demonstrate techniques of estimating building envelop load by using psychrometric chart	**L2**

List of Assignments/Experiments			
Sr. No.	**Details**	**Type**	**Hrs.**
1	Study of various conventional and Nonconventional methods of refrigeration	**O**	**2.00**
2	Study and demonstration on Compressor, Condenser, Evaporator, Expansion, devices, Types, selection. Component balancing, safety devices and refrigeration controls	**O**	**2.00**
3	Study and demonstration of controls and safety devices in refrigeration and air conditioning.	**O**	**2.00**
4	Study and demonstration of dehydration, charging leak testing and testing of refrigeration system with trouble shooting.	**O**	**2.00**
5	Study and trail on vapour absorption system	**O**	**2.00**
6	Trial on Vapor compression refrigeration system.	**O**	**2.00**
7	Trial on ice plant test rig.	**O**	**2.00**
8	Trial on heat pump test rig.	**O**	**2.00**
9	Study and demonstration on air conditioning systems. (Unitary viz Room/Split and Packaged Air Conditioners and central air conditioning/system).	**O**	**2.00**
10	Trial on window Air Conditioning Test Rig.	**O**	**2.00**
11	Market survey of various refrigeration and air conditioning systems which include the equipment's with related specifications, manufacturers, cost and comparison with respect to tonnage, coat and presentation of report in the laboratory.	**O**	**2.00**
12	Visit to central air conditioning or cold storage or dairy plant to ice plant related with refrigeration and air conditioning system.	**O**	**2.00**

Minimum 10 experiments should be carried out to cover the entire curriculum of course.

- **S-STUDY, O-OPERATIONAL**

Textbook:

1. "Refrigeration and Air Conditioning", C. P. Arora, Tata McGraw-Hill Publishing Company Ltd., New Delhi,1981,2ndEdition.
2. "Refrigeration and Air Conditioning", by Er. R. K. Rajput.(3 rd Edition,Katsonbook.)
3. "Refrigeration and Air-conditioning" by Dr. S.N. Sapali, PHI (Second Edition) 2011.

Reference Books:

1. "Basic Refrigeration And Air Conditioning", PN Ananthanarayan Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition,(1981).
2. "Refrigeration and Air Conditioning", Arora Domkundwar, Pearson Education,3 rd Edition.
3. "Refrigeration and Air Conditioning", Stoker.
4. Roy J. Dossat "Principles of Refrigeration", Pearson, fourth edition, 2007.

MECHATRONICS LAB
COURSE CODE: -201MEP402

Course Plan

Course Title : **Mechatronics Lab**	
Course Code : 201MEP402	**Semester : VII**
Teaching Scheme : L-T-P : 0-**0**-**2**	Credits : **1**
ISE: 25	ESE(POE)Marks :**25**

Course Description:

Mechatronics course is of importance due to the global demand and developments in Mechatronics system, Industrial Automation & Robotics, Industry 4.0 automated manufacturing systems, planning and controlling activities etc. For designing and developing mechatronics systems students of mechanical engineering must understand basic elements of mechatronics systems such as sensors, microcontrollers, microprocessors, logic and programs for automating the processes.

Course objective: -

1) To prepare Mechanical Engineering students for advanced graduate studies in Mechatronics, Manufacturing engineering, Industrial automation and related field
2) To introduce graduate of mechanical engineering with working principle of Microprocessor and Microcontroller
3) To provide the fundamentals of PLC programming, ladder diagram and significance of PLC systems in industrial application
4) Understand working principle of Arduino

Course outcomes:-

CO	After the completion of the course, the student should be able to	BTL
CO402.1	Demonstrate the working of sensor by making the connection with PLC.	L2
CO402.2	Understand the principle of Microprocessor and Microcontroller	L2
CO402.3	Write & Demonstrate the PLC programming	L3

List of Assignment/ Experiment

Sr. No.	Name of Assignments/ Experiment	Type	Hrs.
1	Trial on sensor and motors	O	2.00
2	Programming of processor	O	2.00
3	Introduction of Programmable Logic Controller	O	2.00
4	Demonstrating truth tables of logic gates using PLC ladder programming	O	2.00
6	Applications based on timer using PLC ladder programming.	O	2.00
7	Applications based on Counter using PLC ladder programming.	O	2.00
8	Demonstration of different application using PLC ladder programming	O	2.00
9	Demonstration of different application using PLC ladder programming	O	2.00
10	Demonstration of different application using PLC ladder programming	O	2.00
11	Fabrication of Simple Mechatronics working project by a group of 4/5 students using hardware like sensors, signal conditioning, actuators, and suitable software.	O	2.00
12	Fabrication of Simple Mechatronics working project by a group of 4/5 students using hardware like sensors, signal conditioning, actuators, and suitable software.	O	2.00
13	Fabrication of Simple Mechatronics working project by a group of 4/5 students using hardware like sensors, signal conditioning, actuators, and suitable software.	O	2.00
14	Industrial visit to study Mechatronic system, application and submission of visit report.	O	4.00

Minimum 10 experiments should be carried out to cover the entire curriculum of course.

PROFESSIONAL ELECTIVE COURSE –I LAB

AUTOMOBILE ENGINEERING LAB

COURSE CODE: 201MEL403

Course Plan

Course Title : **Automobile Engineering Lab**	
Course Code : **201MEL403**	**Semester : VII**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	

Prerequisite: Basic Mechanical Engineering, I. C Engines.

Course Description:

This course deals with demonstration of different systems of automobiles and conduct experiments for understanding of working of different automobile systems. In this course the student will be given hands on training for automobile maintenance through industrial visit.

Course Objectives:

1. To make students familiar with various basic systems of automobile.
2. To introduce the mathematical treatments required for vehicle performance.
3. To make students aware about latest trends in transportation towards a safe, pollution free and fully automatic vehicle.
4. To empower students to face the real life automotive usage with greater confidence.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO403.1	Understand basic concepts of automobile engineering.	L2
CO403.2	Learn the ability to understand deferent automobile systems and components.	L2
CO403.3	Identify automobile troubleshooting and remedies	L3
CO403.4	Function on automobile engineering laboratory teams.	L3

List of Assignments/Experiments

Sr. No.	Details	Type	Hrs.
1	**Experiment No. 1:---** Study and demonstration of four-wheeler chassis layout and vehicle body parts and its materials.	O	2.00
2	**Experiment No. 2:---** Study and Demonstration of working of single plate automobile clutch and clutch plate lining materials.	O	2.00
3	**Experiment No. 3:---** Study and demonstration of synchromesh gearbox.	O	2.00
4	**Experiment No. 4:---** Study and demonstration of final drive and differential.	O	2.00
5	**Experiment No. 5:---** Study and demonstration of front wheel steering geometry and steering mechanism.	O	2.00
6	**Experiment No. 6:---** Study and demonstration of suspension system of a four-wheeler	O	2.00
7	**Experiment No. 7:---** Study and demonstration of working Hydraulic braking system.	O	2.00
8	**Experiment No. 8:---** Study and demonstration of electrical systems of automobile.	O	2.00
9	**Experiment No. 9:--** Experiment on wheel balancing and wheel alignment.	O	2.00
10	**Experiment No. 10:--** Visit to servicing station for study of vehicle maintenance, repairs and report.	S	2.00

All 10 experiments should be carried out to cover the entire curriculum of course.

- **S-STUDY, O-OPERATIONAL**

Textbook:

1 Kripal Singh, Automobile Engineering Vol II, Standard Publishers Distributors, Tenth Edition, 2007

2 P S Gill, Automobile Engineering II, S K Kataria and Sons, Second Edition, 2012

3 R K Rajput, Automobile Engineering, Laxmi Publications, First Edition, 2007

4 Automobile Engineering", G.B.S. Narang., Khanna Publication, 3rd Edition.

Reference Books:

1 Newton, Steeds and Garrett, The Motor Vehicle, Butterworths International Edition, 11th Edition, 1989

2 Crouse and Anglin, Automotive Mechanics, McGrawhill Publication, Tenth Edition, 2007

3 William Crouse, "Automobile Engineering

PROFESSIONAL ELECTIVE COURSE –I LAB

SUPPLY CHAIN AND LOGISTICS MANAGEMENT LAB

COURSE CODE: 201MEP404

Course Plan

Course Title : **SUPPLY CHAIN AND LOGISTICS MANAGEMENT LAB**	
Course Code : **201MEP404**	**Semester :VII**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE : **25**	

Course Description:

This course provides an integrated view of purchasing, production, inventory, transportation, warehousing and administration.

Course Objectives:

1. Define the objectives, scope and functions of Supply Chain Management.
2. To impart knowledge about different kinds of supply chain relationship operations.
3. To impart knowledge about inventory and Transportation concepts.
4. To make aware with Warehousing, Packaging and Material Handling.
5. To get the feel of Network Integration, Logistics Design and Operational Planning.
6. To get the feel of Supply chain Administration.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO404.1	Understand the objectives, scope and functions of Supply Chain Management.	L-2
CO404.2	Able to Identify kinds of supply chain relationships	L-2
CO404.3	Illustrate Supply Chain Information System Design	L-2
CO404.4	Demonstrate Warehouse Management System	L-2
CO404.5	Explain Logistics Design and Operational Planning	L-2
CO404.6	Outline Overall Supply Chain Logistics Operational Administration	L-2

Course Content

List of Assignments / Case Studies			
Sr. No.	**Content**	**Type**	**Hrs**
1	Assignment on Introduction to Supply Chain Management	S	2
2	Assignment on Demand Planning and Forecasting	S	2
3	Assignment on Customer Accommodation	S	2
4	Assignment on Procurement and Manufacturing Strategies	S	2
5	Assignment on Information Technology Framework	S	2
6	Assignment on Inventory Management	S	2
7	Assignment on Transportation	S	2
8	Assignment on Warehousing	S	2
9	Assignment on Supply Chain Logistics Design	S	2
10	Assignment on Packaging and Material Handling	S	2
11	Assignment on Network Integration	S	2
12	Assignment on Logistics and Operational Planning	S	2
13	Assignment on Supply Chain Logistics Administration	S	2
14	Case study on Logistics	S	2
15	Case study on SUPPLY CHAIN MANAGEMENT	S	2

Minimum 10 experiments should be carried out to cover the entire curriculum of course.

S-STUDY, O-OPERATIONAL

Textbook:

1. "Supply Chain Management -Strategy, Planning & Operation" by Sunil Chopra & Peter Mcindl, Pearson Education Inc, 11th Edition, 2003.
2. "Logistics and Supply Chain Management" by K. Shridhara Bhat, Himalaya Publishing House, 1st Edition, 2016.

Reference Books:

1. Supply Chain Management by Rahul V Altekar, PHI Learning Ltd, New Delhi, 2009.
2. "Strategic Logistics Management" by Douglas Lanibert & James Stock, McGraw Hill, 4th Edition, 2004.

PROFESSIONAL ELECTIVE COURSE –I LAB
ROBOTICS AND AUTOMATION LAB
COURSE CODE: 201MEP405

Course Plan

Course Title : **Robotics and Automation Lab**	
Course Code : **201MEP405**	**Semester : V I I**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	

Prerequisite: Essentials of Electrical and Electronics Technology

Course Description:

The course "Robotics and Automation" provides a comprehensive understanding of robotics and automation in Mechanical Engineering. Students explore robot kinematics, control systems, sensors, actuators, and end effectors. They learn robot programming, machine vision, industrial automation, and SCADA

Course Objectives:

1. To provide fundamental concepts and principles of robotics and automation.
2. To gain knowledge of robot kinematics, dynamics, control systems, and sensor-actuator systems.
3. To develop proficiency in robot programming, machine vision, and industrial automation.
4. To make students aware of Industrial Automation Scenario, development and implementation of SCADA system

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO405.1	Understand basics of Robotics with their classification and anatomy	L2
CO405.2	Define robot kinematic and dynamics parameters to design a robot	L2
CO405.3	Select appropriate sensors, actuators and end effectors for robotic application	L3
CO405.4	Select suitable control system and controller for robot	L3
CO405.5	Generate program for Robotic control as well as implementation of machine vision system in robotics	L3
CO405.6	Develop SCADA System simulation for any Industrial automation scenario	L3

Course content

List of Experiments			
Sr. No.	**Name of Experiment**	**Type**	**Hrs.**
1	Demonstration of various Robotic Configurations	S	2
2	Demonstration of Robot Anatomy	S	2
3	Introduction to Robot Simulation software	O	2
4	Robot Simulation for Pick and Place Application	O	2
5	Robot Simulation for Pick and Place Application	O	2
6	Development of Robotic system using Arduino	O	2
7	Development of Robotic system using Arduino	O	2
8	Development of Machine vision system in Robotics using Arduino	O	2
9	Development of Machine vision system in Robotics using Arduino	O	2
10	Simulation of Industrial System using SCADA	O	2
11	Simulation of Industrial System using SCADA	O	2
12	Simulation of Industrial System using SCADA	O	2
13	Micro Project to design and build a robot for a specific application	O	2
14	Micro Project to design and build a robot for a specific application	O	2
15	Micro Project to design and build a robot for a specific application	O	2

Minimum 10 experiments should be carried out to cover the entire curriculum of course.

S-STUDY, O-OPERATIONAL

Textbook:

1. "Introduction to Robotics" 2nd edition, S. K. Saha, TATA McGraw Hills Education (2014)
2. "Robotics: Fundamental concepts and analysis", Asitava Ghoshal, Oxford University Press (2006

Reference Books:

1. "Fundamentals of Robotics", Dilip Kumar Pratihar, Narosa Publishing House, (2019)
2. "Robotics and Control", R. K. Mittal, I. J. Nagrath, , TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
3. "Introduction to Robotics – Analysis, Control, Applications", S. B. Niku, John Wiley & Sons Ltd., (2020)
4. "Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms", J. Angeles, Springer (1997)
5. "Industrial Robotics 2nd edition", Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, SIE, McGraw Hill Education (India) Pvt Ltd (2012)

Online sources:

1. https://nptel.ac.in/courses/107106090
2. https://nptel.ac.in/courses/108108147

PROJECT PHASE-I

COURSE CODE: 201MEP409

Course Plan

Course Title: **Project Phase-I**	
Course Code: **201MEP409**	Semester: **VII**
Teaching Scheme: **L-T-P: 0-0-4**	Credits: 2
Evaluation Scheme: **ISE Marks: 50**	Evaluation Scheme: **OE Marks: 50**

Course Objectives:

The course aims to:

1. Embed the skill in group of students to work independently on a topic/ problem/ experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.

2. Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision-making process.

Course Outcomes:

CO	Statement	BTL
CO409.1	Improve the professional competency and research aptitude in relevant area.	L5
CO409.2	Develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.	L6

Project Phase I Load:

A batch of maximum three groups of four to five students per group, shall work under one Faculty member of department. The group of one student is strictly not allowed.

Project Phase I Definition:

The project phase I work can be a design project / experimental project and or computer simulation project on Mechanical engineering or any of the topics related with Mechanical engineering stream. The project phase I work is allotted in groups on different topics. The student's groups are required to undertake the project phase-I during the seventh semester and the same is continued in the eighth semester (Phase-II). Project Phase-I consists of reviews of the work carried earlier and the submission of preliminary report. Report should highlight scope, objectives, methodology, approach and tools to be used like software and others, outline of project and expected results and outcome along with timeframe. The project phase I work is to be extended for project phase II at B. E. (Mech.) Sem. VIII with same group working under guidance of same Faculty member assigned for project phase I.

Project Phase I Term Work:

The term work under project submitted by students shall include

1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly. The contents of work diary shall reflect the efforts taken by project group for

   a. Searching suitable project work

   b. Brief report preferably on journals/research or conference papers/books or literature surveyed to select and bring up the project.

c. Day to day activities carried out related to project work for entire semester.

d. Synopsis.
The group should submit the synopsis in following format
i. Title of Project
ii. Names of Students
iii. Name of Guide
iv. Relevance
v. Present Theory and Practices
vi. Proposed work
vii. Expenditure
viii. References

2. The synopsis shall be signed by each student in the group, approved by the guide and endorsed by the Head of the Department
3. Presentation: The group has to make a presentation in front of the Faculty members of department at the end of semester.

Project Phase I Report Format:
Project Phase I report should be of 25 to 30 pages (typed on A4 size sheets). For standardization of the project phase I reports the following format should be strictly followed.
1. Page Size: Trimmed A4
2. Top Margin: 1.00Inch
3. Bottom Margin: 1.32Inches
4. Left Margin: 1.5Inches
5. Right Margin: 1.0Inch
6. Para Text: Times New Roman 12 Point Font
7. Line Spacing: 1.5Lines
8. Page Numbers: Right Aligned at Footer. Font 12 Point. Times New Roman
9. Headings: Times New Roman, 14 Point, Bold Face
10. References: References should have the following format

For Books: "Title of Book", Authors, Publisher, Edition
For Papers: "Title of Paper, Authors, Journal/Conference Details, Year

Important Notes:
- Project group should continue maintaining a diary for project and should write (a) Book referred (b) Company visited (c) Person contacted (d) Computer work done (e) Paper referred (f) Creative thinking.
- The Diary along with Project Phase I Report shall be assessed at the time of oral examination
- One copy of the report should be submitted to Institute/ Department, one copy to Guide and one copy should remain with each student of the project group.

MANDATORY COURSE

INTELLECTUAL PROPERTY RIGHTS (IPR) AND RESEARCH PUBLICATION

COURSE CODE: 201MEMC410

Course Plan

Course Title: **Intellectual Property Rights (IPR) and Research Publication**	
Course Code: **201MEMC410**	Semester: **VIII**
Teaching Scheme: **L-T-P: 2-0-0**	Credits: NA
Evaluation Scheme:	**ESE Marks: 50**

Course Description:

This course is designed to provide students with a comprehensive understanding of Intellectual Property Rights (IPR) and the process of research publication. The course aims to familiarize students with the fundamental concepts of IPR, its relevance in research and innovation, and the procedures involved in publishing research work. Through a combination of theoretical study and practical exercises, students will develop the necessary knowledge and skills to protect intellectual property and effectively communicate research findings through scholarly publications.

Course Objectives:

1. To familiarize students with the fundamental principles and types of Intellectual Property Rights (IPR).
2. To develop an understanding of copyright laws, fair use, and ethical considerations in research.
3. To equip students with the knowledge of patent systems, patentable subject matter, and the process of patent application.
4. To provide insights into trademark registration, infringement, and brand protection strategies.
5. To enable students to navigate the research publication process, including manuscript preparation, peer review, and publication ethics.
6. To enhance academic writing skills and knowledge of proper citation practices.

Course Outcomes:

After the completion of the course the student will be able to

CO	CO statement	Bloom's Level
CO410.1	Recognize the importance of Intellectual Property Rights (IPR) in research and innovation.	**L2**
CO410.2	Apply copyright laws and fair use principles to avoid plagiarism in research and writing.	**L3**
CO410.3	Understand the patent application process and requirements for protecting inventions.	**L2**
CO410.4	Identify trademark registration procedures and strategies for brand protection.	**L2**
CO410.5	Navigate the research publication process and effectively communicate research findings.	**L3**

CO410.6	Demonstrate proficiency in academic writing techniques and proper citation practices.	**L3**

Unit 1: Introduction to Intellectual Property Rights (IPR)

- Course Introduction and Overview
- Understanding Intellectual Property Rights (IPR)
- Types of Intellectual Property (Copyright, Patents, Trademarks, etc.)
- Importance of IPR in Research and Innovation

Unit 2: Copyright and Plagiarism

- Copyright Basics and Principles
- Fair Use and Permissions
- Avoiding Plagiarism in Research and Writing
- Ethical Considerations in Copyright and Plagiarism

Unit 3: Patents and Inventions

- Introduction to Patents and Patent System
- Patentable Subject Matter
- Patent Application Process and Requirements
- Patent Infringement and Enforcement

Unit 4: Trademarks and Brand Protection

- Introduction to Trademarks and Branding
- Trademark Registration Process
- Trademark Infringement and Enforcement
- Brand Protection Strategies

Unit 5: Research Publication Process

- Understanding Scholarly Publishing
- Selecting Suitable Journals and Conferences
- Manuscript Preparation and Submission
- Peer Review Process and Publication Ethics

Unit 6: Academic Writing and Citation

- Effective Academic Writing Techniques
- Formatting and Structure of Research Papers
- Citation Styles (APA, MLA, etc.)

- Avoiding Plagiarism in Academic Writing

Textbooks:

1. "Intellectual Property: Patents, Copyrights, Trademarks, and Allied Rights" by William Fisher (2nd edition, Publisher: West Academic Publishing)
2. "Intellectual Property Law: Text, Cases, and Materials" by Tanya Aplin and Jennifer Davis (3rd edition, Publisher: Oxford University Press)
3. "Intellectual Property: A Very Short Introduction" by Siva Vaidhyanathan (1st edition, Publisher: Oxford University Press)
4. "Understanding Copyright Law" by Marshall Leaffer (7th edition, Publisher: Wolters Kluwer Law & Business)
5. "Patent Law and Policy: Cases and Materials" by Robert Patrick Merges and John Fitzgerald Duffy (5th edition, Publisher: LexisNexis)
6. "Trademark and Unfair Competition Law: Cases and Materials" by Graeme B. Dinwoodie and Mark D. Janis (5th edition, Publisher: Wolters Kluwer Law & Business)

Reference Books:

1. "Intellectual Property Strategy" by John Palfrey (1st edition, Publisher: The MIT Press)
2. "The Oxford Handbook of Intellectual Property Law" edited by Rochelle C. Dreyfuss, Justine Pila, and Annette Kur (1st edition, Publisher: Oxford University Press)
3. "Research Ethics and Integrity for Social Scientists: Beyond Regulatory Compliance" by Mark Israel and Iain Hay (1st edition, Publisher: SAGE Publications Ltd)
4. "The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams (4th edition, Publisher: The University of Chicago Press)
5. "Publication Manual of the American Psychological Association" by American Psychological Association (7th edition, Publisher: American Psychological Association)
6. "A Manual for Writers of Research Papers, Theses, and Dissertations" by Kate L. Turabian (9th edition, Publisher: University of Chicago Press)

FINITE ELEMENT ANALYSIS

COURSE CODE: 201MEP411

Course Plan

Course Title : **Finite Element Analysis**	
Course Code : **201MEL411**	**Semester : VIII**
Teaching Scheme : L-T-P : **3-0-0**	Credits : 3
Evaluation Scheme : ISE + MSE Marks: **20+30**	ESE Marks : **50**

Prerequisite: Engineering Mathematics, Applied Mechanics, Strength of Materials, Machine Design, Fluid Mechanics, Heat & Mass Transfer.

Course Description:

This subject enables the student to understand the important concepts of FEA, its evolution and applications. Students will learn the mathematical formulation of real-world problems using FEA. The knowledge gained through this subject will be helpful in solving the real-life problems.

Course Objectives:

1. Introduce students to Finite Element Analysis fundamentals.

2. Introduce students to steps involved in FEA, domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.

3. To enable the students to formulate the design problems into FEA.

4. Understand the practical (modeling and analysis) aspects of the FEA.

5. Apply this theory and practical knowledge to solve 1-d, 2-d structural and thermal problems manually and with using computers.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO411.1	Elaborate the fundamental concepts of Finite Element method.	L2
CO411.2	Understand the application of discretization techniques.	L2
CO411.3	Apply finite element formulation to solve 1 D problems to evaluate deformation, strain & stress.	L5
CO411.4	Apply the finite element formulations for two dimensional problems using CST element.	L3
CO411.5	Apply the finite element formulations for Planer Trusses using 1D element.	L3
CO411.6	Demonstrate the modeling aspects of axisymmetric solids subjected to axisymmetric loading.	L3

Course Content

Content	Hours
Unit 1 Introduction Introduction, past present and future of FEM, Importance of FEA, Methods of solving engineering problems, basic concept of FEM, steps in FEM, Types of problems investigated, applications of FEM, advantages of FEM.	06.00 hrs
Unit 2 Discretization of The Problem and Interpolation Models Geometrical approximations, simplification through geometry, basic element shapes and behavior, choice of element type, size and number of elements, element and node numbering. Simplex, complex and multiplex elements, linear interpolation polynomials for simplex elements	06.00 hrs
Unit 3 One Dimensional Element Introduction to One dimensional element, Types of One-dimensional element, Derivation of Stiffness matrix and Shape function for one dimensional Linear and Quadratic element. Stress analysis of a Stepped bar, Thermal analysis of a Composite Wall and Torsion analysis of a shaft using 1 D element. Treatment of Boundary conditions by Elimination approach and Penalty approach.	08.00 hrs
Unit 4 Two-Dimensional Element Introduction to two-dimensional element, Constant strain triangle (CST) & Linear strain triangle (LST) Element, Derivation of Stiffness matrix and Shape function for two-dimensional linear element. Numerical treatment using CST element.	08.00 hrs
Unit 5 Analysis of Truss Trusses: Plane trusses, Local and Global coordinate systems, Derivation of Global stiffness matrix, Formulae for calculating L and M, element stiffness matrix, Stress Calculations, Assembly of global stiffness matrix, numerical treatment on plane truss.	08.00 hrs
Unit 6 Analysis of Axisymmetric Solids Introduction & applications of Axisymmetric elements, axisymmetric formulation, finite element modeling, triangular element and stress calculations (Theoretical approach)	08.00 hrs

Text Books:

1. “Introduction to Finite Elements in Engineering”; Chandrupatala, Belgundu, PHI.
2. “Finite Element Method with Application in Engineering” Y. M. Desai, T. I. Eldho, A. H. Shah, Pearson.
3. “Textbook of Finite Elements Analysis”, P. Sheshu, Prentice-Hall of India Private Limited, New Delhi.
4. “An Introduction to Finite Element Method”; J. N. Reddy; 2/e, McGraw Hill International Editions, ISBN

0-07-112799-2
5. Finite Element Analysis – Theory and Practice"; M.J. Fagan, Longman Scientific &Technical.

Reference Books:

1. "Practical Finite Element Analysis", N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A.N.Thite, Finite to Infinite Publication.
2. "Concepts of Finite Element Methods",Manicka Selvam, SCITECH publication
3. "Finite Elements Analysis – Theory and Application with ANSYS, Sawed Mouveni, Prentice HallInc.
4. "Applied Finite Elements Analysis", Larry J. Segerlind, BSP Books Pvt Ltd.

Online Links for Course

https://nptel.ac.in/courses/112104193
https://nptel.ac.in/courses/112104116

PROFESSIONAL ELECTIVE COURSE -II

LEAN MANUFACTURING

COURSE CODE: 201MEL412

Course Plan

Course Title : **Lean Manufacturing**	
Course Code : **201MEL412**	**Semester :VIII**
Teaching Scheme : L-T-P : 3-**0-0**	Credits : 3
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Metrology and Quality Control

Course Description:

This Lean Manufacturing course offers an overview of lean manufacturing techniques and initial advice on how to implement them. It elaborates various TQM Tools and Techniques. It also provides an understanding of concepts related to Total Productive Maintenance, Design of Experiments, Designing for Quality, Six Sigma and Quality Circle.

Course Objectives:

1. An understanding of primary and secondary tools of lean manufacturing.
2. An understanding of Total Productive Maintenance
3. Impart knowledge of TQM tools and techniques
4. Impart knowledge of Total Productive Maintenance.
5. Awareness of Taguchi approach
6. An understanding of Six Sigma and Quality Circle

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO412.1	Understand Primary tools of lean manufacturing.	L2
CO412.2	Understand Secondary tools of lean manufacturing.	L2
CO412.3	Describe TQM tools and Techniques.	L2
CO412.4	Discuss the concept of Total Productive Maintenance.	L2
CO412.5	Implement the Taguchi Approach.	L3
CO412.6	Implement the Six Sigma and Quality Circle concept.	L3

Course Content

Content	Hours
Unit 1: Introduction Lean Manufacturing Introduction, Definitions of Lean manufacturing, basic concepts. Overview of Historical development. Management theory. **Primary Tools of Lean manufacturing** 5-S, Workplace Organization, Total Productive Maintenance (TPM), Process Mapping / Value Stream Mapping, Work cell.	06.00 hrs
Unit 2: Secondary Tools of Lean manufacturing: Objective and benefits of Secondary Lean tool, Cause and Effect diagram, Pareto Chart, Spider chart, Poka Yoke, Kanban, Single minute exchange of die (SMED), Design for manufacturing and assembly, just in time (JIT), Visual workplace, Overall Equipment Effectiveness (OEE)	08.00 hrs
Unit 3: TQM Tools and Techniques The seven traditional tools of quality, new management tools, Bench marking, Reason to bench mark, Bench marking process, Implementing Total Quality Management - An Integrated System Approach	08.00 hrs
Unit 4: Total Productive Maintenance: Objectives and functions, Tero Technology, Reliability Centered Maintenance (RCM), Maintainability prediction, availability and system effectiveness, maintenance costs, maintenance organization. Minimal repair, maintenance types, balancing PM and breakdown maintenance.	06.00 hrs
Unit 5: Design of Experiments: Introduction, Methods, Taguchi approach, Achieving robust design, Steps in experimental design **Designing for Quality:** Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis (FMEA), Concept, Methodology and Application. Quality in Service Sectors: Characteristics, Quality Dimensions in Service Sectors, Measuring Quality in Different Service Sectors.	08.00 hrs
Unit 6: Six Sigma Meaning of six sigma, Why six sigma, DMAIC and DMADV principle, building six sigma organization and culture, Six sigma application. **Quality Circle:** Quality Circle structure, Its operation, Characteristics of Quality Circle, developing quality circle in organization, Basic problem solving techniques.	09.00 hrs

Textbooks:

1. "Total Quality Management–Text and cases", Jankiram Anand Gopal, Prentice Hall India Publication. (ISBN978-81-203-2995-9).
2. "Mitra A., "Fundamentals of Quality Control and Improvement", PHI, 2nd Ed., 1998.
3. "Pascal Dennis, "Lean Production Simplified" 3rd Edition, 2015.
4. "Besterfield, D H et al., "Total Quality Management", 3rd Edition, Pearson Education, 2008.

Reference Books:

1. “K C Jain and A K Chitale, “Quality Assurance and Total Quality Management (ISO 9000, QS9000 ISO 14000)” by, Khanna Publishers, 2010.
2. “D. C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, 6 th Edition, 2004.
3. “J Evans and W Linsay, The Management and Control of Quality, 6 th Edition, Thomson, 2005.

PROFESSIONAL ELECTIVE COURSE -II

NOISE AND VIBRATION

COURSE CODE: 201MEL413

Course Plan

Course Title: **NOISE AND VIBRATION**	
Course Code: **201MEL413**	**Semester: VIII**
Teaching Scheme: L-T-P : **3-0-0**	Credits: **3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks: **50**

Prerequisite: Basic Engineering Mathematics, Basic Engineering Physics, Kinematics and Theory of Machines, Machine Design

Course Description:

Noise and Vibration is the study and modification of the noise and vibration characteristics of mechanical systems. The course intends to provide knowledge of Mechanical Vibrations and foundations of noise. The course includes analysis of single and multi-degrees of freedom system, analysis of continuous system along with experimental methods and Noise harshness analysis.

Course Objectives:

1. To study Fundamental concepts of Noise and Vibrations
2. To study Single Degree, Two Degree and Multi Degree of Freedom System
3. To study Noise and Vibration Measuring Instruments and Conditioning Monitoring of Systems
4. To Study the effect of Noise Vibration Harshness in Mechanical Systems
5.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO413.1	Understand Fundamentals of Mechanical Vibrations	L2
CO413.2	Examine Damped Free and Force Vibrations of SDoF Systems	L4
CO413.3	Analyze Two Degree and Multi Degree of Freedom System	L4
CO413.4	Use of Vibration Measuring Instruments for measuring various vibration parameters	L3
CO413.5	Apply Principles of Condition Monitoring Systems	L3
CO413.6	Identify the sources of noise and the ways to control it.	L2

Course Content

Unit No. 01: Fundamentals of Mechanical Vibrations. Vibration and oscillation, Causes and effects of vibrations, Vibration parameters – spring, mass, damper, Motion – periodic, non-periodic, harmonic, non- harmonic, Degree of freedom, Static equilibrium position, Vibration classification, Steps involved in vibration analysis, Simple harmonic motion, Equivalent stiffness of spring combination, un-damped free vibration.	8.00 hrs
Unit No. 02: Damped Free and Force Vibrations of SDoF Systems. Damped free vibrations, Types of damping, Logarithmic decrement and damping materials. Forced Vibrations: Types of excitations, Forced excitation, Transmissibility-Force transmissibility and motion transmissibility, Vibration isolators, commercial isolation materials and shock mounts.	9.00 hrs
Unit No. 03: Two and Multi Degree of Freedom Systems. a) Free undamped vibrations, Co-ordinate coupling and principal coordinates, Undamped Forced vibrations - Harmonic excitation, Vibration Dampers and absorbers. b) Free vibrations of Multi DOF System-Flexibility and stiffness influence coefficient matrix, Rayleigh's method and Holzer method.	9.00 hrs
Unit No. 04: Noise and Vibration Measuring Instruments. Instruments for measurement of displacement, velocity, acceleration & frequency of vibration, Sensors and Actuators, Introduction of X – Y plotter, Spectral Analyzers, FFT Analyzer, Sound Level Meter	6.00 hrs
Unit No. 05: Introduction to Condition Monitoring Systems. Vibration trouble-shooting and diagnosis; time-domain and frequency-domain vibration analysis, Noise Vibration and Harshness Analysis of Machines, Applications of IoT in Condition Monitoring	6.00 hrs
Unit–06: - Noise Generated by Vibrating Systems and its Control. Design principles for noise reduction. Frequency dependent human response to sound, Sound pressure dependent human response, Decibelscale, Relation among sound power, Sound intensity and sound pressure level, Auditoryand Non auditory effectsof noise on Human, Noise standards and its limits.	7.00 hrs

Text Books:

1. "Mechanical Vibrations", Singiresu S. Rao, Pearson Education, ISBN –81-297-0179-0-
(2004).
2. "Mechanical Vibrations", G. K. Grover, Published by Nemchand and Brothers,Roorkee.
3. "Mechanical Vibrations", Dr. V. P. Singh, Published by S. Chand and Sons NewDelhi.
4. "Noise and Vibration Control", Leo L. Bernack, Tata Mc- GrawHillPublication.
5. "Mechanical Vibration and Noise Engineering",A. G. Ambekar, Prentice Hall ofIndia.

Reference Books:

1. “Mechanical Vibration", Austin Church, Wiely Eastern. 2ndEdition.
2. “Schaumm's Outline Series in Mechanical Vibration”, S. Graham Kelly, 6thEdition.
3. “Kinematics, Dynamics and Design of Machinery", Waldron, Willey India, 2ndEdition.
4. “Mechanical Vibrations ”,J.P.DenHartog,Tata Mc Grawhill Book CompanyInc.,4th Edition.
5. “Introduction to Dynamics and Control”, Leonard Meirovitch, J. Wiley, New York.
6. “Elements of Vibration Analysis” Leonard Meirovitch, Tata Mc Graw-Hill, New York. 2nd Edition.

Online Resurces:

1. https://archive.nptel.ac.in/courses/112/103/112103112/
2. https://archive.nptel.ac.in/courses/112/103/112103112/
3. https://archive.nptel.ac.in/courses/112/105/112105232/
4. https://archive.nptel.ac.in/noc/courses/noc17/SEM2/noc17-me32/

PROFESSIONAL ELECTIVE COURSE -II

ENERGY AND POWER ENGINEERING

COURSE CODE: 201MEL414

Course Plan

Course Title : **ENERGY AND POWER ENGINEERING**	
Course Code : 201MEL414	**Semester : VIII**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Basic mechanical Engineering, Thermodynamics, Heat and Mass Transfer,

Course Description:

This subject enables the student to understand basic principle of different type of renewable sources. Students will also learn new trends in power and energy sectors. Understand the working principles & concept of various power stations, Performance and economic analysis.

Course Objectives:

1. To understand basic principles of solar Energy & solar photovoltaic system.
2. To understand basic principles and working of wind energy.
3. To understand the different types of power plant, & power scenario in India
4. To understand concept of different type of Instrumentation use for power plants and Load Curves and Load duration curves
5. To understand the Energy Marketing and Management.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO414.1	Describe the basic details of solar energy & equipment's used for the measurement of solar irradiation.	**L2**
CO414.2	Demonstrate working of solar photovoltaic system.	**L2**
CO414.3	Demonstrate working of wind energy.	**L2**
CO414.4	Explain the basic working principles of steam, hydel, diesel, as turbine power plant and boilers.	**L2**
CO414.5	Demonstrate basics of Load Curves and Load duration curves & Know the costs associated with power generation.	**L3**
CO414.6	Understand the Energy Marketing and Management.	**L2**

Course Content

Unit-1 **Introduction of Energy and Power plant :** Introduction to Renewable and non-Renewable Energy sources. Different types of power plants – Solar, wind, Gas, Tidal. Geothermal Thermal, Hydro, IC Engine, Gas Turbine, Nuclear and their characteristics, Comparison of Power plants with respect to various parameters, Issues in Power plants Power scenario in India and world, NTPC, NHPC and their role in Power development in India, Power generation in Private sector, Power distribution, Power grid corporation of India, State grids, Railway grids and International grids.	7.00 hrs
Unit-2 **Solar energy** Introduction Solar energy , Solar potential, Solar radiation spectrum, Solar radiation geometry, Solar radiation data, Solar Collectors - flat plate, evacuated tube, Cylindrical parabolic, Concentrating parabolic, various Collectors, Modern thermal energy storage - Ultra capacitors / Super capacitors, Super conducting materials, New generation batteries.	6.00 hrs
Unit-3 **Solar photovoltaic system** Operating Principle of Photovoltaic cell concepts, Photo-cell materials, Cell module array, Series and parallel connections, Maximum power point tracking, Study of standalone system with battery and AC or DC load, Hybrid systems (Diesel-PV, Wind-PV, Biomass-Diesel systems), Applications,	7.00 hrs
Unit-4 **Wind energy** Wind parameters and wind data, Power from wind, Site selection, Wind energy conversion systems and their classification, Construction and working of typical wind mill, Introduction to OTEC.	5.00 hrs
Unit-5 **Instrumentation & Load Curves** Flow measurement of feed water, fuel, air, steam with correction factor for temperature, Speed measurement, Level recorders, Radiation detectors, Smoke density measurement, Dust monitor, Flue gas oxygen analyzer – Analysis of impurities in feed water and steam – Dissolved oxygen analyzer – Chromatography – PH meter – fuel analyzer – Pollution monitoring instruments, Integration of instrumentation system. Load Curves and Load duration curves (Numerical treatments), Performance and operational characteristics of power plants, Peak load, Intermediate load and Base load plants and their characteristics, Input output characteristics of power plants, Economic division of between Base load plant and peak load plants, Tariff methods.	9.00 hrs

Unit-6 **Energy Marketing and Management** Energy Management, Energy Marketing: Selling and marketing in India, Creating supply chain in India, Successfully working with business and virtual teams in India, Navigating the financial, legal and accounting environment, Human Resources issues, India's business culture in energy sector, Conservation of energy.	6.00 hrs

Textbook:

1. "Solar Energy", S.P.Sukhatme and J.K.Nayak, Tata McGraw-Hill, 3 rd Edition,(2008).
2. "Non-Conventional Energy Sources", G.D.Rai.-Khanna Publisher, 4 thEdition.
3. "Power Plant Technology", M.M.ElWakil, Tata McGraw-Hill. Int, 2 nd Edition. Reprint, (2010).
4. "Power Plant Engineering", Domkundwar and Arora, Dhanpatrai andSons.

Reference Books:

1. "Solar Photovoltaic Fundamentals, Technologies and Applications", Chetan Singh Solanki, Prentice Hall of India Publications.
2. "Modern Power Station Practice", Vol.6, Instrumentation, Controls and Testing, by Pergamon Press, Oxford,(1971).
3. "Power System Analysis", Grainger John J, and Stevenson Jr.. W.D., Tata McGraw Hill, (2003).
4. "Economic Operation of Power Systems", L.K. Kirchmeyer, John Wiley and Sons, (1993).

PROFESSIONAL ELECTIVE COURSE -III
ADDITIVE MANUFACTURING

COURSE CODE: 201MEL415

Course Plan

Course Title: **ADDITIVE MANUFACTURING**	
Course Code: **201MEL415**	Semester: **VIII**
Teaching Scheme: **L-T-P: 3-0-0**	Credits: 3
Evaluation Scheme: **ISE + MSE Marks: 20 + 30**	**ESE Marks: 50**

Pre-requisites:

Manufacturing Processes, CAD

Course Description:

Additive Manufacturing is a course that covers the basics of modern 3D printing technology. In this course, students will learn about the different types of additive manufacturing processes, including Fused Deposition Modeling (FDM), Stereolithography (SLA), Selective Laser Sintering (SLS), and others. They will also learn about the materials used in additive manufacturing, such as plastics, metals, and ceramics, and the properties that make them suitable for different applications. The course will cover the principles of design for additive manufacturing, including the use of CAD software to create 3D models and the optimization of part orientation and support structures. Students will also learn about the post-processing techniques used to finish and refine parts after they have been printed. Additionally, the course will discuss the applications of additive manufacturing in various industries, such as aerospace, automotive, medical, and consumer products. Students will explore case studies of successful applications of 3D printing technology, as well as emerging trends and future possibilities. By the end of the course, students will have a solid understanding of additive manufacturing and its potential applications, as well as hands-on experience with 3D printing technology. They will be equipped with the skills and knowledge necessary to design and manufacture their own parts using additive manufacturing techniques.

Course Objectives:

1. To provide comprehensive knowledge of the wide range of additive manufacturing processes, capabilities and materials
2. To understand the software tools and techniques used for additive manufacturing.
3. To create physical objects that facilitates product development/prototyping requirements.
4. To study various post processing techniques of AM

Course Outcomes:

After the completion of the course the student will be able to

CO	CO statement	Bloom's Level
CO415.1	Elaborate the fundamental concepts of Additive Manufacturing/3D Printing.	L2
CO415.2	Discuss Principles and different materials used in FDM and SLA printing.	L2
CO415.3	Discuss Principles and different materials used in Directed Energy Deposition, Material Jetting, Binder Jetting, Powder Bed Fusion, and Sheet Lamination.	L2
CO415.4	Describe the process of 3D modeling for additive manufacturing, including the use of CAD software.	L3
CO415.5	Identify specific parts used in different applications that can be produced using additive manufacturing.	L3
CO415.6	Explore various techniques used to enhance the properties of additive manufacturing parts.	L3

Unit 1 : Introduction to Additive Manufacturing Definition of Additive Manufacturing (3D Printing), Additive vs Subtractive Manufacturing , Rapid prototyping (RP) , Historical development of Rapid Prototyping , Areas of Application (Basic Introduction) Advantages and Limitations of Additive Manufacturing, Commonly used Terms, Classification of Additive Manufacturing Processes, : Process overviews, Steps Involved.	6.00 hrs
UNIT 2: Additive Manufacturing Processes I: Fused Deposition Modelling and Stereo lithography Fused Deposition Modelling (FDM): FDM Technology, Various FDM Printers and Specifications, Process Parameters of Models and specifications, Process, Materials for FDM, Their Application areas and Caparison, Applications, Advantages and Disadvantages. Stereo lithography (SLA): Specifications of SLA Printers , Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages.	10.00 hrs
UNIT 3: Additive Manufacturing Processes II: Directed Energy Deposition, Material Jetting, Binder Jetting, Powder Bed Fusion, Sheet Lamination etc.: Specifications, Process Parameters of Models and specifications, Process, Materials, Application areas and Comparison, Applications, Advantages and Disadvantages.	8.00 hrs
UNIT 4 : Design Potential of Rapid Prototyping: Aspects of CAD for Additive Manufacturing (3D Modelling, Slicing, STL file Generation	8.00 hrs

etc.) Conventional design for manufacturing and assembly (DFM, DFMA), Geometrical freedom, design complexity/ optimization, parts consolidation, body fitting customization and multiple assemblies manufactured as one, Customer input and customization. 3D Scanning and digitization, AM Software: data formats and standardization, Slicing algorithms , Advanced Slicing	
UNIT 5 : Applications of Additive Manufacturing Form and fit checking, Ergonomic Studies, Functional testing, Automotive applications- Parts of racing cars, Applications in Aerospace industry, Construction industry, Applications in Medical field , Rapid Tooling: Mold making, Rapid tooling for die, permanent mold casting, Rapid manufacturing of sheet metal forming tools, casting pattern plates by rapid tooling, RP for series production investment casting, Advances in Additive Manufacturing	6.00 hrs
UNIT 6: Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, and Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques. Details of Sanding, Vapor Smoothing, Priming & Painting, Polishing, Coating, Electroplating, Welding etc.	6.00 hrs

Textbooks

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2015.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2010.

Reference Books

1. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.
2. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC Press, 2000

Online Links for Course

- Virtual Labs : https://3dp-dei.vlabs.ac.in/

PROFESSIONAL ELECTIVE COURSE -III

INDUSTRIAL ENGINEERING

COURSE CODE: 201MEL416

Course Plan

Course Title : **INDUSTRIAL ENGINEERING**	
Course Code : **201MEL416**	**Semester :VIII**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Operations Research and Project Management.

Course Description:

This course covers various topics concerned with Productivity, Method Study, Motion Study & Human Factor Engineering (Ergonomics), Work Measurement (Time Study), Facility Design, Value analysis & Job evaluation and merit rating. It deals with utilizing and coordinating humans, machines and materials to attain desired output rate with the optimum utilization of energy, knowledge, money, and time.

Course Objectives:

1. To introduce students the concepts, principles and framework of Industrial Engineering and various productivity enhancement techniques.
2. To understand Method study and time study techniques.
3. To acquaint the students with tools and technique of material handling.
4. To acquaint the students the concept of value analysis, job evaluation and merit rating.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO416.1	Evaluate the productivity	**L-2**
CO416.2	Apply the work study techniques	L-3
CO416.3	Measure and estimate the standard time for job.	L-2
CO416.4	Apply Ergonomics and legislations aspects for human comfort at work place	L-3
CO416.5	Select the plant location, the appropriate layout	L-2
CO416.6	Understand the role of value engineering in improving productivity.	L-3

Course Content

Content	Hours
Unit 1 : Introduction to Industrial Engineering & Productivity **Introduction:** Definition, Scope, Responsibilities, Brief history of IE, Tools and techniques of industrial engineering. **Productivity:** Concept, objectives, Factors affecting productivity, Tools and techniques to improve productivity, Productivity measurement models	07.00 hrs
Unit 2: Method Study Role of work study in improving productivity, method study procedure, selection of jobs, information, collection and recording; Recording techniques, charts, diagrams, templates, models, critical analysis, development, installation, and maintaining better method	08.00 hrs
Unit 3 : Motion Study & Human Factor Engineering (Ergonomics) **A) Motion Study:** Principles of motion economy, micro motion study, SIMO chart, MEMO motion study, cycle graph, chronocycle graph **B)Human Factor Engineering (Ergonomics):** Introduction, objectives definition, man machine system, physiological work measurement, multidisciplinary approach of ergonomics, design of controls.	08.00 hrs
Unit 4 : Work Measurement (Time Study) Definition, objectives, techniques, procedure, Types of elements, time study equipment, performance rating, allowances, concept of normal time and standard time, calculation of standard time, comparison of various techniques, work sampling, predetermined motion time analysis.	08.00 hrs
Unit 5 : Facility Design Plant site selection, factors influencing the selection, optimum decision on choice of site and analysis, types of plat layout, advantages and disadvantages of layout, principles and objectives of plant layout, tools and techniques of layout planning, Computer aided layout design techniques; Assembly line balancing Material Handling- Objective, elements, functions, principles, types of material handling equipments.	08.00 hrs
Unit 6 : Value analysis & Job evaluation and merit rating Definition, concept of approaches of value analysis and engineering, steps, evaluation, and applications of value analysis, when to apply value analysis, ten principles of value analysis. **Job evaluation and merit rating**: Definition, objectives, procedure of job evaluation, different schemes and their advantages and disadvantages.	06.00 hrs

Textbook:

1. “Introduction to Work Study, ILO, Geneva and Oxford and IBH Publi. Co. Pvt.Ltd.
2. M. Telsang, “Industrial Engineering and Production Management”, S. ChandPublication.
3. L.C. Jhamb, “Industrial Engineering”, Everest Publication,Pune.
4. O.P. Khanna, “Work Study” DhanpatRaiPubli. NewDelhiInternal Combustion Engines”, Ganesan. V. , Tata McGraw Hill

Reference Books:

1. R.M. Barnes, “Motion and time study design and measurement of work” John Willey &Sons Inc. 7th Edi.
2. H.B. Maynard and others, “Industrial Engg. Handbook” IVth Edi. McGraw HillPubli.
3. J.AdamEE,RJEbert“ProductionandOperationManagement”,PrenticeHallEnglewoodCliff N.
4. David Sumanth, “Productivity Engg. And Management”, Tata McGraw Hill, NewDelhi.
5. Gavrial Salvendy” Hand book of Industrial engineering” John Wiley andsons,New York,2007
6. M. I. Khan “Industrial engineering” New age international(P) ltd, NewDelhi,2004.
7. International labour office, “Introduction to work study” Publisher International labour office,1969.

PROFESSIONAL ELECTIVE COURSE -III
INDUSTRY 4.0
Course Code: 201MEL417

Course Plan

Course Title : **INDUSTRY 4.0**	
Course Code : 201MEL417	**Semester :VIII**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Essentials of Electrical and Electronics Technology, Mechatronics

Course Description:

This course provides a comprehensive introduction to Industry 4.0, covering its history, key technologies, and concepts. Students will explore the application of Industry 4.0 in manufacturing processes, including Industrial IoT, smart factories, digital twins, and predictive maintenance. The course also examines social and ethical implications, and real-world case studies.

Course Objectives:

5. To make students aware about Industry 4.0 technologies: IoT, AI, CPS.
6. To Explore Industry 4.0 applications: smart factories, digital twins, predictive maintenance.
7. To gain knowledge about Programming Language and Tools used in Industry 4.0
8. Evaluate social and ethical impact: workforce, sustainability, responsibility.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO417.1	Understand basic of Industry 4.0	L2
CO417.2	Select suitable programming language or tool for Industry 4.0 application	L2
CO417.3	Demonstrate Industrial IoT system	L3
CO417.4	Investigate Smart Manufacturing and Smart Factory scenarios	L3
CO417.5	Develop digital twin for any industrial application	L4
CO417.6	Develop model for predictive maintenance	L4

Course Content

Content	Hours
Unit 1: Introduction to Industry 4.0 Overview of Industry 4.0: definition, history, and key drivers, Key technologies and concepts associated with Industry 4.0, such as IoT, AI, and CPS, Importance and benefits of Industry 4.0 in the manufacturing industry, Impact of Industry 4.0 in the Manufacturing Sector, Social Aspects of Industry 4.0	06..00 hrs
Unit 2: Programming Languages and Software Tools Introduction to programming languages commonly used in Industry 4.0 applications (e.g., Python, C++, Java), Introduction to software tools used in Industry 4.0 applications (e.g., MATLAB, Simulink, LabVIEW), Basics of programming for Industry 4.0 application	08.00 hrs
Unit 3: Industrial Internet of Things (IIoT). Introduction to IIoT, Sensors: various sensors used for data acquisition in industrial environment, and data acquisition techniques and protocols in IIoT, Data communication and networking for IIoT, Cloud computing and big data analytics for IIoT, Security and privacy issues in IIoT.	09.00 hrs
Unit 4: Smart Manufacturing and Smart Factories Introduction to smart Manufacturing, Cyber-physical systems and their integration in smart manufacturing, Digital manufacturing and product lifecycle management, Definition and principles of smart factories, Key technologies enabling smart factories, such as robotics, additive manufacturing, automation etc., Quality Control and Inspection in Smart Factories	09.00 hrs
Unit 5: Digital Twins: Definition and principles of digital twins, Benefits and applications of digital twins in the manufacturing industry, Development of Digital Twin System, Examples of digital twin implementation in real-world scenarios	07.00 hrs
Unit 6: Predictive Maintenance Definition and principles of predictive maintenance, Key technologies enabling predictive maintenance, such as machine learning and analytics, Types of digital twin and their applications, Digital Twin modelling and simulation, Optimization and Control using Digital Twin, Case studies and examples of successful implementation of predictive maintenance in manufacturing and production processes	06.00 hrs

Textbook:

1. "Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries" by Almas Heshmati
2. "Industry 4.0: An Overview of Key Technologies and Applications" by Gerhard Banse and Alwin Hoffmann

Reference Books:

1. "Industry 4.0: Managing the Digital Transformation" by Alp Ustundag and Emre Cevikcan
2. "IoT Enabled Cyber-Physical Systems: From Sensor Data to Analytics" by Houbing Song, Danda B. Rawat, and Sabina Jeschke
3. "Digital Twins: Realizing the Cyber-Physical Production System for Industry 4.0" by Matthias Putz and Dieter Hess
4. "Predictive Maintenance: Tools and Techniques" by D. N. Prabhakar Murthy

Online sources:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

PROJECT PHASE-II

COURSE CODE: 201MEP418

Course Plan

Course Title: **Project Phase-II**	
Course Code: **201MEP418**	Semester: **VIII**
Teaching Scheme: **L-T-P: 0-0-6**	Credits: 4
Evaluation Scheme: **ISE Marks: 50**	**OE Marks: 50**

Course Objectives:

The course aims to:

1. Embed the skill in group of students to work independently on a topic/ problem/ experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.

2. Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision-making process.

Course Outcome:

CO	Statement	BTL
CO418.1	Improve the professional competency and research aptitude in relevant area.	L5
CO418.2	Develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.	L6

Project Phase II Load:

A batch of maximum three groups of four to five students per group, shall work under one Faculty member of department. The group of one student is strictly not allowed. Same groups of Seventh Semester shall work under same faculty member of department.

Project Phase II Definition:

Project phase-II is a continuation of project phase-I started in the seventh semester. Before the end of the eighth semester, there will be two reviews, one at start of the eighth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre-qualifying exercise for the students for getting approval for the submission of the thesis. The final evaluation of the project will be external evaluation.

Project Phase II Term Work:

The term work under project submitted by students shall include

1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly. The contents of work diary shall reflect the efforts taken by project group for a. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring up the project.

c. Brief report of feasibility studies carried to implement the conclusion.

d. Rough Sketches/ Design Calculations/ Testing reports/ Experimentation results.

Project Report:

Project report should be of 50 to 60 pages (typed on A4 size sheets). For standardization of the project reports the following format should be strictly followed.

1. Page Size: TrimmedA4
2. Top Margin: 1.00Inch
3. Bottom Margin: 1.32Inches
4. Left Margin: 1.5Inches
5. Right Margin: 1.0Inch
6. Para Text: Times New Roman 12 Point. Font
7. Line Spacing: 1.5 Lines
8. Page Numbers: Right Aligned at Footer. Font 12 Point Times New Roman
9. Headings: Times New Roman, 14 Point Boldface
10. Certificate: All students should attach standard format of Certificate as described by the department. Certificate should be awarded to batch and not to individual student.
Certificate should have signatures of Guide, Head of Department and Principal/Director
11. Index of Report:
    - i) Title Sheet
    - ii) Certificate
    - iii) Acknowledgement
    - iv) Table of Contents.
    - v) List of Figures
    - vi) List of Tables
        1. Introduction
        2. Literature Survey/Theory
        3. Design/ Fabrication/ Production/ Actual work carried out for the same and Experimentation.
        4. Observation Results
        5. Discussion on Result and Conclusion
12. References: References should have the following format

For Books: "Title of Book", Authors, Publisher, Edition

For Papers: "Title of Paper, Authors, Journal/Conference Details, Year

13. The Project report shall be signed by each student in the group, approved by the guide and endorsed by the Head of the Department
14. Presentation: The group has to make a presentation in front of the faculty of department at the end of semester.

Important Notes:

• Project group should continue maintaining a diary for project and should write (a) Books referred (b) Company visited (c) Person contacted (d) Computer work done (e) Paper referred (f) Creative thinking.

• The Diary along with Project Report shall be assessed at the time of oral examination

• One copy of the report should be submitted to Institute/ Department, One copy to Guide and one copy should remain with each student of the project group.

FINITE ELEMENT ANALYSIS LAB

COURSE CODE: 201MEP411

Course Plan

Course Title : **FINITE ELEMENT ANALYSIS LAB**	
Course Code : **201MEP411**	**Semester : VIII**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	POE Marks : 25

Prerequisite: Engineering Mathematics, Applied Mechanics, Strength of Materials, Machine Design, Fluid Mechanics, Heat & Mass Transfer.

Course Description:

This lab enables the student to understand the important concepts of FEA, its evolution and applications. Students will learn the mathematical formulation of real-world problems using FEA. The knowledge gained through this subject will be helpful in solving the real-life problems.

Course Objectives:

1. To study discretization techniques.
2. To calculate the stress, temperature and other related parameters in Structural Analysis & heat transfer
3. To use commercial software for Structural Analysis & heat transfer

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO411.1	Understand different discretization techniques.	L2
CO411.2	Solve 1 D and 2D Structural Analysis problems to evaluate deformation, stress, strain and reaction	L5
CO411.3	Solve 1 D Heat transfer problem to evaluate temperature distribution and heat flux	L5

List of Assignments			
Sr. No.	**Name of Assignments**	**Type**	**Hrs.**
1	Assignment on Discretization – types of elements, choice of element and type of meshing – automatic, mapped, meshing in critical areas.	S	2
2	Finite Element Analysis of Stepped bar (Two or Three Steps only) using Finite Element Approach (Theory)	O	2
3	Finite Element Analysis of Stepped bar (Two or Three Steps only) using Finite Element Software (ANSYS) Compare the results obtained by above methods.	O	2
4	Finite Element Analysis of Stepped bar (Two or Three Steps only) using Finite Element Software (ANSYS) Compare the results obtained by above methods.	O	2
5	Finite element analysis of Composite wall (Minimum three slabs) using Finite Element Approach (Theory)	O	2
6	Finite element analysis of Composite wall (Minimum three slabs) using Finite Element Software (ANSYS) Compare the results obtained by above methods.	O	2
7	Finite element analysis of Composite wall (Minimum three slabs) using Finite Element Software (ANSYS) Compare the results obtained by above methods.	O	2
8	Use of ANSYS Workbench for solving Static Analysis of Truss problems	O	2
9	Use of ANSYS Workbench for solving Static Analysis of Truss problems	O	2
10	Use of ANSYS Workbench for solving Static Analysis of Beam problems	O	2
11	Use of ANSYS Workbench for solving Static Analysis of Plate with a circular hole problem	O	2
12	Use of ANSYS Workbench for solving Thermal analysis of Composite wall under Convection & Conduction problem	O	2
13	Use of ANSYS Workbench for solving Torsional Analysis of a shaft problem	O	2
14	Use of ANSYS Workbench for solving Analysis of Wall bracket problem	O	2
15	Use of ANSYS Workbench for solving Analysis of 1D heat transfer problem	O	2

Minimum 10 experiments should be carried out to cover the entire curriculum of course.
S-STUDY, O-OPERATIONAL

Note: Solve problems by using ANSYS Workbench

Textbook:

1. "Introduction to Finite Elements in Engineering"; Chandrupatala-Belgundu, PHI.
2. "Finite Element Method with Application in Engineering" Y. M. Desai, T. I. Eldho, A. H. Shah, Pearson.
3. "Textbook of Finite Elements Analysis", P. Sheshu, Prentice-Hall of India Private Limited, New Delhi.

Reference Books:

1. "Practical Finite Element Analysis", N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A. N. Thite, Finite to Infinite Publication.
2. "Concepts of Finite Element Methods",Manicka Selvam, SCITECH publication
3. "Finite Elements Analysis – Theory and Application with ANSYS, Sawed Mouveni, Prentice Hall Inc.
4. "Applied Finite Elements Analysis", Larry J. Segerlind, BSP Books Pvt Ltd.

PROFESSIONAL ELECTIVE COURSE II LAB
LEAN MANUFACTURING LAB
COURSE CODE: 201MEP412

Course Plan

Course Title : **LEAN MANUFACTURING LAB**	
Course Code : **201MEP412**	**Semester :VIII**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE : **25**	

Course Description:

This course will provide the student understanding

Course Objectives:

1. An understanding of primary and secondary tools of lean manufacturing.
2. An understanding of Total Productive Maintenance
3. Impart knowledge of TQM tools and techniques
4. Impart knowledge of Total Productive Maintenance.
5. Awareness of Taguchi approach
6. An understanding of Six Sigma and Quality Circle

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO412.1	Describe concepts lean manufacturing.	L-2
CO412.2	Describe tools of lean manufacturing.	L-2
CO412.3	Describe TQM tools and Techniques.	L-2
CO412.4	Describe concepts Total Productive Maintenance.	L-3
CO412.5	Implement Taguchi Method.	L-2
CO412.6	Implement Six Sigma And Quality Circle concepts.	L-2

Course Content

List of Assignments / Case studies			
Sr. No.	**Content**	**Type**	**Hrs**
1	Assignment on Introduction to Lean Manufacturing	S	2
2	Assignment on TQM Tools and Techniques as Poka Yoke	S	2
3	Assignment on TQM Tools and Techniques as 5 S	S	2
4	Assignment on TQM Tools and Techniques as KANBAN	S	2
5	Assignment on TQM Tools and Techniques as KAIZEN	S	2
6	Assignment on TQM Tools and Techniques as Just in Time (JIT)	S	2
7	Assignment on TQM Tools and Techniques as Value Stream Mapping (VSM)	S	2
8	Assignment on TQM Tools and Techniques Overall Equipment Effectiveness (OEE)	S	2
9	Assignment / Case Study on Total Productive Maintenance	S	2
10	Assignment on Taguchi Approach	S	2
11	Assignment on Quality Function Deployment (QFD)	S	2
12	Assignment on FMEA	S	2
13	Assignment / Case Study on Six Sigma	S	2
14	Assignment / Case Study on Quality Circle (manufacturing industry case)	S	2
15	Assignment / Case Study on Quality Circle (service sector industry case)	S	2

Minimum 10 experiments should be carried out to cover the entire curriculum of course.

S-STUDY, O-OPERATIONAL

Textbooks:

1. "Total Quality Management–Text and cases", Jankiram Anand Gopal, Prentice Hall India Publication. (ISBN978-81-203-2995-9).
2. "Mitra A., "Fundamentals of Quality Control and Improvement", PHI, 2nd Ed., 1998.
3. "Pascal Dennis, "Lean Production Simplified" 3rd Edition, 2015.
4. "Besterfield, D H et al., "Total Quality Management", 3rd Edition, Pearson Education, 2008.

Reference Books:

1. "K C Jain and A K Chitale, "Quality Assurance and Total Quality Management (ISO 9000, QS9000 ISO 14000)" by, Khanna Publishers.
2. "D. C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, 6th Edition, 2004.
3. "J Evans and W Linsay, The Management and Control of Quality, 6'th Edition, Thomson, 2005.

PROFESSIONAL ELECTIVE COURSE II LAB
NOISE AND VIBRATION LAB
COURSE CODE: LC201MEP413

Course Plan

Course Title : **NOISE AND VIBRATION LAB**	
Course Code : **LC201MEP413**	**Semester : VIII**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	

Prerequisite: Basic Engineering Mathematics, Basic Engineering Physics, Kinematics and Theory of Machines, Machine Design

Course Description: Noise and Vibration is the study and modification of the noise and vibration characteristics of mechanical systems. The course intends to provide knowledge of Mechanical Vibrations and foundations of noise. The course includes analysis of single and multi-degrees of freedom system, analysis of continuous system along with experimental methods and Noise harshness analysis

Course Objectives:

1. To study Equivalent Spring mass system
2. To study Logarithmic Decrement of SDoF an Underdamped System
3. To study forced vibration Characteristics of Spring mass system
4. To study torsional vibration of two rotors and Three Rotor without damping
5. To study Measurement of vibration parameters using vibration measuring instruments

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO413.1	Examine Damped Free and Force Vibrations of SDoF Systems	L4
CO413.2	Analyze Two Degree and Multi Degree of Freedom System	L4
CO413.3	Use of Vibration Measuring Instruments, modern tools, software for measuring various vibration parameters	L3
CO413.4	Apply Principles of Condition Monitoring Systems	L3
CO413.5	Identify the sources of noise and the ways to control it.	L2

List of Assignments/Experiments			
Sr. No.	**Details**	**Type**	**Hrs.**
1	Determination of Natural frequency for Two Pendulum System	O	2.00
2	Experiment on equivalent spring mass system	O	2.00
3	Experiment on study of forced vibration characteristics	O	2.00
4	Determination of logarithmic decrement for single DOF damped system	O	2.00
5	Experiment on torsional vibration of two rotors without damping	O	2.00
6	Experiment on torsional vibration of three rotors without damping	S	2.00
7	Use of different types of exciters for vibration analysis.	O	2.00
8	Measurement of vibration parameters using vibration measuring instruments	S	2.00
9	Introduction to FFT analyzer	O	2.00
10	Measurement of Noise by using noise measuring instruments.	S	2.00
11	Case Study on Condition Monitoring and Fault Diagnosis	S	2.00
12	Case Study on Noise Vibration Harshness Analysis	O	2.00
13	Modelling and Simulation of Vibrating System using suitable Software Package	O	2.00
14	Use of FFT Analyzer for prediction of spectral response of vibrating machine from workshop	S	2.00
15	Industrial Visit	S	2.00

Minimum 10 experiments should be carried out to cover the entire curriculum of course.
S-STUDY, O-OPERATIONAL

Text Books:

1. “Mechanical Vibrations”, Singiresu S. Rao, Pearson Education, ISBM –81-297-0179-0-(2004).

2. “Mechanical Vibrations”, G. K. Grover, Published by Nemchand and Brothers,Roorkee.

3. “Mechanical Vibrations”, Dr. V. P. Singh, Published by S. Chand and Sons NewDelhi.

4. “Noise and Vibration Control”, Leo L. Bernack, Tata Mc- Graw HillPublication.

5. “Mechanical Vibration and Noise Engineering”,A. G. Ambekar, Prentice Hall ofIndia.

Reference Books:

1. “Mechanical Vibration", Austin Church, Wiely Eastern. 2ndEdition.
2. “Schaumm's Outline Series in Mechanical Vibration”, S. Graham Kelly, 6thEdition.
3. “Kinematics, Dynamics and Design of Machinery", Waldron, Willey India, 2ndEdition.
4. “Mechanical Vibrations ”,J.P.Den Hartog,Tata Mc Grawhill Book CompanyInc.,4th Edition.
5. “Introduction to Dynamics and Control”, Leonard Meirovitch, J. Wiley, New York.
6. “Elements of Vibration Analysis” Leonard Meirovitch, Tata Mc Graw-Hill, New York. 2nd Edition.

Online Resurces:

1. https://archive.nptel.ac.in/courses/112/103/112103112/
2. https://archive.nptel.ac.in/courses/112/103/112103112/
3. https://archive.nptel.ac.in/courses/112/105/112105232/
4. https://archive.nptel.ac.in/noc/courses/noc17/SEM2/noc17-me32/

PROFESSIONAL ELECTIVE COURSE II LAB
ENERGY AND POWER ENGINEERING LAB
COURSE CODE: 201MEP414

Course Plan

Course Title : **ENERGY AND POWER ENGINEERING LAB**	
Course Code : 201MEP414	**Semester : VIII**
Teaching Scheme : L-T-P : 0-**0-2**	Credits : **1**
ISE Marks : **25**	

Prerequisite: Basic mechanical Engineering, Thermodynamics, Heat and Mass Transfer,

Course Description:

The course deals with various assignments related to renewable and nonrenewable energy, solar power plants, wind power plant, load curve, energy managements so as to understand the fundamentals and application energy and power plant. Also market survey and case3 study of energy system helps understand the concept and application of energy and power plant.

Course Objectives:

1. To provide the students the fundamentals of renewable and nonrenewable energy
2. To train students with good scientific and engineering breadth in the areas of renewable and nonrenewable energy, & energy managements, so as to comprehend, analyze, design and create novel products and solutions for the real-life problems

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO414.1	Understand various renewable and non-renewable power plants	L2
CO414.2	Explain solar power plants & solar photovoltaic	L2
CO414.3	Demonstrate Load Curves and Load duration curves	L3
CO414.4	Understand Indian electricity grid code.	L2
CO414.5	Interpret Energy Audit	L3
CO414.6	Analyse Market survey of various renewable and nonrenewable energy systems.	L2

List of Assignments/Experiments			
Sr. No.	**Details**	**Type**	**Hrs.**

1	Study of various renewable and nonrenewable power plants	**S**	**2.00**
2	Study of solar power plants and collectors.	**S**	**2.00**
3	Study of solar photovoltaic system	**S**	**2.00**
4	Study wind energy	**S**	**2.00**
5	Study of Instrumentation used in power plants Load Curves	**S**	**2.00**
6	Study of Load Curves and Load duration curves	**S**	**2.00**
7	Study of Energy Marketing and Management	**S**	**2.00**
8	Study of Indian electricity grid code.	**S**	**2.00**
9	Industrial visit to any power plant / Survey based / Project based industrial visit.	**S**	**2.00**
10	Energy Audit - Case study of an organization and report	**S**	**2.00**
11	Market survey of various renewable and nonrenewable systems which include the equipment's with related specifications, manufacturers, cost and comparison with respect to tonnage, coat and presentation of report in the laboratory.	**S**	**2.00**

Minimum 10 experiments should be carried out to cover the entire curriculum of course.

- **S-STUDY, O-OPERATIONAL**

Textbook:

1. "Solar Energy", S.P.Sukhatme and J.K.Nayak, Tata McGraw-Hill, 3 rd Edition,(2008).
2. "Non-Conventional Energy Sources", G.D.Rai.-Khanna Publisher, 4 thEdition.
3. "Power Plant Technology", M.M.ElWakil, Tata McGraw-Hill. Int, 2 nd Edition. Reprint, (2010).
4. "Power Plant Engineering", Domkundwar and Arora, Dhanpatrai andSons.

Reference Books:

1. "Solar Photovoltaic Fundamentals, Technologies and Applications", Chetan Singh Solanki, Prentice Hall of India Publications.
2. "Modern Power Station Practice", Vol.6, Instrumentation, Controls and Testing, by Pergamon Press, Oxford,(1971).
3. "Power System Analysis", Grainger John J, and Stevenson Jr.. W.D., Tata McGraw Hill, (2003).
4. "Economic Operation of Power Systems", L.K. Kirchmeyer, John Wiley and Sons,(1993)

PROFESSIONAL ELECTIVE COURSE III LAB
ADDITIVE MANUFACTURING LAB
COURSE CODE: 201MEP415

Course Plan

Course Title : **ADDITIVE MANUFACTURING LAB**	
Course Code : **201MEP415**	**Semester :VIII**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	

Prerequisite: Manufacturing Processes, CAD

Course Description:

The Additive Manufacturing Lab provides students with a hands-on experience in modern 3D printing technology. This lab complements the theoretical knowledge gained in the Additive Manufacturing course by focusing on practical applications and techniques. Students will have the opportunity to work with different types of additive manufacturing processes, including Fused Deposition Modeling (FDM), Stereolithography (SLA), Selective Laser Sintering (SLS), and more. They will gain proficiency in using additive manufacturing equipment and software to create functional 3D printed objects.

Course Objectives:

4. To study discretization techniques.
5. To calculate the stress, temperature and other related parameters in Structural Analysis & heat transfer
6. To use commercial software for Structural Analysis & heat transfer

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO415.1	Understand different discretization techniques.	L2
CO415.2	Solve 1 D and 2D Structural Analysis problems to evaluate deformation, stress, strain and reaction	L5
CO415.3	Solve 1 D Heat transfer problem to evaluate temperature distribution and heat flux	L5

List of Experiment / Assignments			
Sr. No.	**Name of Experiment / Assignments**	**Type**	**Hrs.**
1	Study of a FDM 3 D Printer and its various elements and a Virtual lab on FDM Printer	S	2
2	Study of Slicing Software Ultimaker Cura and other Software	O	2
3	Build Time Assessment : Evaluate effect of various process parameters on Build Time	O	2
4	Print Quality Assessment: Evaluate the impact of different print settings, such as layer height, print speed, and infill density, on the quality of FDM prints. Measure and compare factors like dimensional accuracy, surface finish.	O	2
5	Design and Development / Selection of a Product using FDM Technology (Design)	O	2
6	Design and Development / Selection of a Product using FDM Technology (Design)	O	2
7	Design and Development / Selection of a Product using FDM Technology (Design)	O	2
8	Design and Development / Selection of a Product using FDM Technology (Slicing and Priting)	O	2
9	Design and Development / Selection of a Product using FDM Technology (Printing)	O	2
10	Study of a SLA 3 D Printer and its various elements and a Virtual lab on SLA Printer	O	2
11	Investigate the effect of varying exposure times print quality and curing depth. Print test specimens using different exposure times and measure the dimensional accuracy and surface finish.	O	2
12	Comparison of FDM ad SLA Technologies	O	2
13	Advanced Slicing Options	O	2
14	Industrial or Lab Visit Report on various 3D Printing Technologies	S	2
15	Industrial or Lab Visit Report on various 3D Printing Technologies	S	2

Minimum 10 experiments should be carried out to cover the entire curriculum of course.
S-STUDY, O-OPERATIONAL, D-DRAWING SHEET

Textbooks

1. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2015.
2. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, Third edition, World Scientific Publishers, 2010.

Reference Books

1. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 2011.
2. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
3. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC Press, 2000

Online Links for Course

- Virtual Labs : https://3dp-dei.vlabs.ac.in/

PROFESSIONAL ELECTIVE COURSE III LAB
INDUSTRIAL ENGINEERING LAB
COURSE CODE: 201MEP416

Course Plan

Course Title : **Industrial Engineering Lab**	
Course Code : **201MEP416**	**Semester :VIII**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE : **25**	

Course Description:

This course covers various topics concerned with Productivity, Method Study, Motion Study & Human Factor Engineering (Ergonomics), Work Measurement (Time Study), Facility Design, Value analysis & Job evaluation and merit rating. It deals with utilizing and coordinating humans, machines and materials to attain desired output rate with the optimum utilization of energy, knowledge, money, and time.

Course Objectives:

1. To introduce students the concepts, principles and framework of Industrial Engineering and various productivity enhancement techniques.
2. To understand Method study and time study techniques.
3. To acquaint the students with tools and technique of material handling
4. To acquaint the students the concept of value analysis, job evaluation and merit rating.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO416.1	Evaluate the productivity	**L-2**
CO416.2	Apply the work study techniques	L-3
CO416.3	Measure and estimate the standard time for job.	L-2
CO4164	Apply Ergonomics and legislations aspects for human comfort at work place	L-3
CO416.5	Select the plant location, the appropriate layout	L-2
CO4166	Understand the role of value engineering in improving productivity.	L-3

Course Content

List of Assignments/Case Study			
Sr. No.	**Content**	**Type**	**Hrs**
1	Assignment on Introduction to Industrial Engineering	S	2
2	Assignment on problems on productivity.	S	2
3	Case study on method study.	S	2
4	Assignment on Man, Machine chart program.	S	2
5	Case Study on Two handed process chart.	S	2
6	Case study on Ergonomics (for One Product)	S	2
7	Stop watch time study for an operation.	S	2
8	Assignment on influence of methods and Time Study on production Activities.	S	2
9	Assignment on Computations of standard time.	S	2
10	Assignment on work sampling.	S	2
11	Assignment on plant site location analysis.	S	2
12	Assignment on Material Handling.	S	2
13	Assignment on plant layout.	S	2
14	Case study on Value analysis concept.	S	2
15	Case study on job evaluation and merit rating.	S	2

Minimum 10 experiments should be carried out to cover the entire curriculum of course.
S-STUDY, O-OPERATIONAL

Textbook:

1. “Introduction to Work Study, ILO, Geneva and Oxford and IBH Publi. Co. Pvt.Ltd.

2. M. Telsang, “Industrial Engineering and Production Management”, S. ChandPublication.

3. L.C. Jhamb, “Industrial Engineering”, Everest Publication,Pune.

4. O.P. Khanna, “Work Study” DhanpatRaiPubli. NewDelhiInternal Combustion Engines”, Ganesan. V. , Tata McGraw Hill

Reference Books:

1. R.M. Barnes, “Motion and time study design and measurement of work” John Willey & Sons Inc. 7th Edi.
2. H.B. Maynard and others, “Industrial Engg. Handbook” IVth Edi. McGraw HillPubli.
3. J.AdamEE,RJEbert“ProductionandOperationManagement”,PrenticeHallEnglewoodCliff N.
4. David Sumanth, “Productivity Engg. And Management”, Tata McGraw Hill, NewDelhi.
5. Gavrial Salvendy” Hand book of Industrial engineering” John Wiley andsons,New York,2007
6. M. I. Khan “Industrial engineering” New age international(P) ltd, NewDelhi,2004.
7. International labour office, “Introduction to work study” Publisher International labour office,1969.

PROFESSIONAL ELECTIVE COURSE III LAB

INDUSTRY 4.0 LAB

COURSE CODE: 201MEP417

Course Plan

Course Title : **Industry 4.0 Lab**	
Course Code : 201MEP417	**Semester :VIII**
Teaching Scheme : L-T-P : 0-**0-2**	Credits : 1
Evaluation Scheme : ISE Marks: 25	

Prerequisite: ESSENTIALS OF ELECTRICAL AND ELECTRONICS TECHNOLOGY, Mechatronics

Course Description:

This course provides a comprehensive introduction to Industry 4.0, covering its history, key technologies, and concepts. Students will explore the application of Industry 4.0 in manufacturing processes, including Industrial IoT, smart factories, digital twins, and predictive maintenance. The course also examines social and ethical implications, and real-world case studies.

Course Objectives:

1. To make students aware about Industry 4.0 technologies: IoT, AI, CPS.
2. To Explore Industry 4.0 applications: smart factories, digital twins, predictive maintenance.
3. To gain knowledge about Programming Language and Tools used in Industry 4.0
4. Evaluate social and ethical impact: workforce, sustainability, responsibility.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
C417.1	Understand basic of Industry 4.0	L2
C417.2	Select suitable programming language or tool for Industry 4.0 application	L2
C417.3	Demonstrate Industrial IoT system	L3
C417.4	Investigate Smart Manufacturing and Smart Factory scenarios	L3
C417.5	Develop digital twin for any industrial application	L4
C417.6	Develop model for predictive maintenance	L4

List of Experiments			
Sr. No.	**Name of Experiment**	**Type**	**Hrs.**
1	Demonstration of various IoT systems	S	2
2	Development of IoT system using Arduino	O	2
3	Development of IoT system using Arduino	O	2
4	Design a Smart Factory system using Arduino	O	2
5	Design a Smart Factory system using Arduino	O	2
6	Design of a digital Twin System	O	2
7	Design of a digital Twin System	O	2
8	Implementation of predictive maintenance system using Arduino	O	2
9	Implementation of predictive maintenance system using Arduino	O	2
10	Implementation of predictive maintenance system using Arduino	O	2
11	Design of Cyber-Physical System	O	2
12	Group Project to implement Industry 4.0 system: Idea Generation and Concept Finalization	O	2
13	Group Project to implement Industry 4.0 system: Design	O	2
14	Group Project to implement Industry 4.0 system: Implementation	O	2
15	Group Project to implement Industry 4.0 system: Testing	O	2

- **Minimum 10 experiments should be carried out to cover the entire curriculum of course.**
- **S-STUDY, O-OPERATIONAL**

Textbook:

1. "Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries" by Almas Heshmati
2. "Industry 4.0: An Overview of Key Technologies and Applications" by Gerhard Banse and Alwin Hoffmann

Reference Books:

1. "Industry 4.0: Managing The Digital Transformation" by Alp Ustundag and Emre Cevikcan
2. "IoT Enabled Cyber-Physical Systems: From Sensor Data to Analytics" by Houbing Song, Danda B. Rawat, and Sabina Jeschke
3. "Digital Twins: Realizing the Cyber-Physical Production System for Industry 4.0" by Matthias Putz and Dieter Hess
4. "Predictive Maintenance: Tools and Techniques" by D. N. Prabhakar Murthy

Online sources:

https://onlinecourses.nptel.ac.in/noc20_cs69/preview

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