Syllabus

and

Course Outcomes

M.Tech in

Mechanical Engineering

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Advanced Machine Design	**3. Course Code**	**4. L-T-P**	**5. Credits**
	Code: MEL560	2-1-0	3
6. Type of Course (Check one):	Programme Core ✓ Programme Elective ☐ Open Elective ☐		
7. Frequency of offering (check one): Odd ☐ Even ✓ Either semester ☐ Every semester ☐			
8. Brief Syllabus: Design methodology (Phases of a design project, Need identification and problem formulation, Designing to codes and standards); Failure theories (static failure theories, fatigue failure, fracture mechanics); Stress analysis and design of machine elements under conditions of impact, inertial forces, thermal, and residual stresses; Surface Failure (Surface geometry, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue, Spherical contact, Cylindrical contact); Reliability engineering (Distribution models, Probabilistic approach to design, Definition of reliability, Constant and variable failure rates, System reliability, Maintenance and repair, Design for reliability, FMEA, Fault tree analysis)			
9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)			
Lectures: 28 hours	**Tutorials: 14**	**Practice: --**	

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Prepare mission and requirement documents for a design project based on the requirements of the stakeholders and available resources.
CO 2	Do basic stress analysis of components under conditions of shock, impact, inertial forces, thermal, initial and residual stresses.
CO 3	Explain the causes and mechanisms of surface failures and propose basic solutions to mitigate them.
CO 4	Explain the basics of reliability engineering and apply them in design of machine components.

11. UNIT WISE DETAILS No. of Units: ___4_____

Unit Number: 1 No. of Lectures: 5 Title: Design methodology

Phases of a design project; Considerations of a good design; Need identification and problem formulation; product design specification document; Designing to codes and standards

Unit Number: 2 No. of Lectures: 8 Title: Stress analysis

Content Summary: Failure theories (static failure theories, fatigue failure, fracture mechanics); Stress analysis and design of machine elements under conditions of impact, inertial forces, thermal, and residual stresses

Unit Number: 3 No. of Lectures: 5 Title: Surface failure

Content Summary: Surface geometry, friction, adhesive wear, abrasive wear, corrosion wear, surface fatigue, spherical contact, cylindrical contact

Unit Number: 4 No. of Lectures: 9 Title: Reliability engineering

Content Summary: Distribution models: Exponential, Weibull, Normal, Lognormal, Gumbel, bath-tub, etc.; Probabilistic approach to design; Definition of reliability; Constant and variable failure rates; system reliability; Maintenance and repair; Design for reliability; FMEA; Fault tree analysis

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Some parts of the surface engineering unit should be left for self-study

13. Books Recommended :

Text Books:

1) Marshek, K.M., Juvinall, R.C., “Machine Component Design”, 5th edition, Wiley, 2012.

2) Schmidt, L.C., Dieter, G., "Engineering Design", 4th edition, McGraw Hill Education, 2013.

Reference Books:

1) Collins, J.A., Busby, H., Staab, G.,“Mechanical Design of Machine Elements and Machines”, 2nd edition, Wiley, 2011.

2) Hertzberg, R.W., Vinci, R.P., Hertzberg, J.L., "Deformation and Fracture Mechanics of Engineering Materials", 5th edition, Wiley, 2012.

3) Raju, N.V.S., “Plant Maintenance and Reliability Engineering”, Cengage Learning, 2011.

4) Shigley, J., Mischke, C., Brown, T.H., "Standard Handbook of Machine Design", 3rd edition, McGraw Hill, 2004.

Reference websites:

https://ocw.mit.edu/courses/mechanical-engineering/2-72-elements-of-mechanical-design-spring-2009/lecture-

notes/ http://www.weibull.com/

The practice part will have following components

Sr. No.	Topic	Cos covered
1.	Group discussions for framing design requirements	1
2.	Solving numericals related to Stress analysis	2
3.	Solving numericals related to Stress analysis	2
4.	Solving numericals related to Stress analysis	2
5.	Presentations by students on their mini projects	1
6.	Case studies on stress analysis of machine elements	2
7.	Solving numericals related to surface wear	3
8.	Case studies on surface wear	3
9.	Solving numericals related to reliability	4
10.	Solving numericals related to reliability	4
11.	Presentations by students on their mini projects	4
12.	Clearing doubts and solving problems on selected topics	all
13.	Clearing doubts and solving problems on selected topics	all

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Waste management	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL 590N	2- 0-2	3
6. Type of Course (Check one):	Programme Core ☐	Programme Elective ☑	Open Elective ☐
7. Frequency of offering (check one):	Odd ☐	Even ☐	Either semester ☐	Every semester ☑

8. Brief Syllabus: Ecosystem, waste movement, UN SDG goals, waste handling and generation, consumption, pollution, types of waste, different classifications, waste characterization, Categories of Solid Wastes, E- waste generation & handling, Solid Waste management tools – techniques for reducing production of waste, managing through segregation and scientific disposal, Waste reduction strategies, Economic benefits, Conventional Practices vs Modern Practices; Life Cycle Analysis, Extended Producer Responsibility, Ecological Footprint, Sustainable consumption production.

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28 hours	**Tutorials: ---**	**Practice: 28 hours**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	To provide insights in basics of environment and waste.
CO 2	To sensitize and make students aware of environmental health and individual responsibility in waste management
CO 3	To provide insights in waste characterization and source reduction
CO 4	To provide insights in sustainability tools, sustainable production – consumption.

11. UNIT WISE DETAILS **No. of Units: 05**

Unit Number: 1 **No. of Lectures: 4** **Title: Introduction to Environment** **Content Summary**: Ecosystem, Components- Structure – Functions, Levels of organization in nature- Food chain and Trophic structure, Biogeochemical Cycles, Understanding Carrying Capacity and Assimilation Capacity of Earth, UN Sustainable Development Goals, waste movement – cyclic vs linear, innovating techniques to revert from linear to cyclic movement.
Unit Number: 2 **No. of Lectures: 6** **Title: Waste Generation** **Content Summary:** Waste around us, factors affecting generation, Waste Handling in Previous Ages, Increasing waste piles – indicates inefficient use of raw material; Reasons for increase in waste quantity, Consumption and population, consumption patterns, Exponential growth of consumption, Effects of Excess Waste Generation, Resource depletion, waste disposal vs waste management, Principles of waste management, Rural waste vs Urban Waste; Pollution – types, waste vs pollution, Statistics for exponential growth of waste generation.
Unit Number: 3 **No. of Lectures: 8** **Title: Waste Characterization** **Content Summary:** Types of waste; geographical waste or regional waste; Solid Waste management tools – techniques for reducing production of waste, managing through segregation and scientific disposal, Ill-effects of mixing of waste, Categories of Solid Wastes – Domestic Waste, Market Waste, Food Waste, Agricultural waste, Fruit- vegetable market waste, E-Waste, Industrial Inert Waste, Industrial Hazardous Waste, Bio-Medical Waste and Radioactive Waste, Hazardous waste, Plastic Waste – spread all over oceans, Managing them at source, Next Generation Waste, inventorisation or projection of waste, Domestic waste vs industrial waste; Domestic waste vs institutional waste, C & D waste, Laboratory waste management; non-routine waste(like festivals or functions), E-waste generation scenario.
Unit Number: 4 **No. of Lectures: 6** **Title: Source Reduction & Waste Disposal Practices** **Content Summary:** Source Reduction, Waste reduction strategies, Economic benefits, Demarcations between Source Reduction and Waste Reduction, Operation on a daily basis, Waste Reduction Program Guideline, Importance of source reduction, Economic benefits of waste reduction, Operation on a daily basis, Innovations examples of waste reduction Waste Disposal Practices: Conventional Practices vs Modern Practices; Dumping off wastes; Landfill, Recycling; Biological Recycling; Recovery for Energy;

Incineration Urban growth – Municipal management – Administrative framework – Present scenario of solid waste management in ULBs and Rural areas – Current practices and deficiencies in SWM

Unit Number: 5 **No. of Lectures: 4** **Title: Sustainability Tools**

Content Summary: Life Cycle Analysis, Extended Producer Responsibility, Corporate Social Responsibility in waste management, Introduction, Environmental Management Systems, Cradle to Cradle design, Natural Capitalism, Ecological Footprint, Small Business is ideal, Sustainable materials usage; Take – back Policy; Carbon Credits

12. Brief Description of Self-learning component by students (through books/resource material etc.):

E- waste management, waste water and its treatment.

13. Contextual learning component(s)

Videos related to waste related statistics, problems – solutions and demonstration of real-life based WM projects.

14. Books Recommended:

Text Books:

1) Introduction to Waste Management, Syed E. Hassan; Wiley- Blackwell;

2) Waste Management Practices; John Pichtel; 2nd Edition CRC Press

Reference Books:

1) Solid wastes management by Stephen Burnley.

2) Text book of Solid Wastes Management by Naved Ahsan & Iqbal H.Khan

Reference websites:

NPTEL online courses

http://mgncre.org/

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	COs covered
1.	• Outline the tutorial objectives and tutorial work plan • Outline the evaluation and marking scheme • Explaining course outcomes(Cos) • Introductory topics of the subject • Environment, ecosystem, Biomes, • Waste generation, consumption patterns • Waste characterization • Film Analysis on related topics	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Tutorial Sheet 1, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted •	CO1
2.	• Waste generation , handling, measurement • Waste characterization • WM techniques	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO2
Minor Test			
3.	• Source reduction • Waste Disposal Practices	• Tutorial Sheet 3, Doubt clearance	CO3
4.	Self-study topics: waste water, E – waste management Case studies/real life examples	• Tutorial Sheet 4, Doubt clearance • Assignment • Through discussion, Presentation or video demonstration	CO3 CO4

Practical Content

Sr. No.	Title of the experiment/case study	Performance based/ study based experiments	Unit covered
1.	Demonstrations of on-campus/local waste generation & waste disposal methods	Study based	All
2.	Written reports /case studies on waste	Study based	All

	management in Indian cities.		
3.	Design/analysis exercises related to waste recycling systems, inclusive of a conceptual design project.	Study based	All
4.	Household waste generation and disposal practices	Study based	All

1.	**Case study/ mini project (to be allotted during the semester)**	To be done individually or in groups, Discussion and presentation by the students and addressing the problems given in assigned study	Semester

Evaluation Scheme:

Theory Part (80 Marks) □ Major: **45 Marks (45%)** □ Minor: **25 Marks (25%)** □ Online Quiz (s): **10 Marks (10%)**
Practical Part (Total 20 marks) □ Assignment, Class Tests, presentations, projects: **20 Marks (20%)**
Total 100 Marks **Note:** in order to pass this course a student must secure 30% marks in minor + major with overall 40% marks in total

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Renewable Energy Sources	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL 611TH	2- 0-2	3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ✓ Open Elective ✓		
7. Frequency of offering (check one): Odd ☐ Even ☐ Either semester ☐ Every semester ✓			

8. Brief Syllabus: National and International energy scenario; Energy security and climate change; Various forms of renewable energy sources; concept of sustainability; their relative merits and demerits and barriers to their commercialization; Solar energy: solar heating and cooling, solar thermal and photovoltaic power generation systems, Wind energy-types of wind mills; hydro power plants; Biomass energy; biofuels and biomass, Digesters-fixed and floating digester biogas plants; Geothermal energy; Ocean thermal energy; Hydrogen as an alternative fuel and fuel cell, magneto hydrodynamic power generations.; Liveliest cost of energy and grid parity, case study on solar energy system, wind conversion system, biomass and geothermal energy system; Cost benefit analysis and environment concerns of conventional source of energy

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28 hours	**Tutorials: ---**	**Practice: 28 hours**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Recognize the need of renewable energy technologies and their role in India and world energy demand.
CO 2	Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment
CO 3	Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources
CO 4	List and describe the primary renewable energy resources and technologies.
CO 5	Compare the pros and cons of various renewable energy technologies and propose the best possible energy conversion system for a particular location.
CO 6	Apply the knowledge of thermodynamic and heat transfer principles to evaluate the

	performance of energy conversion systems for maximum efficiency

11. UNIT WISE DETAILS **No. of Units: 07**

Unit Number: 1 **No. of Lectures: 4** **Title: Introduction to RES**

Content Summary: Energy Scenario: Classification of Energy Sources, Energy resources (Conventional and nonconventional), Energy needs of India, and energy consumption patterns. Worldwide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts, Distributed generation Carbon footprint and its estimation, Economics

Unit Number: 2 **No. of Lectures: 6** **Title:** Solar Energy

Content Summary: Solar Energy: Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, Solar radiation and its measurement, scope, applications. Photo voltaic (PV) technology: Present status, solar cells, cell technologies, characteristics of PV systems, equivalent circuit, array design, building integrated PV system, its components, sizing and economics. Peak power operation. Standalone and grid interactive systems. hurdles in its utilization, environmental effects

Unit Number: 3 **No. of Lectures: 4** **Title:** Wind Energy

Content Summary: Wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, Types of Turbine, Turbine rating. Choice of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation.

Unit Number: 4 **No. of Lectures: 4** **Title:** Water Energy

Content Summary: Hydro Power: Selection of site for hydroelectric power plant, Classification of Hydroelectric power plants, Essential elements of a Hydroelectric power plant, Hydraulic Turbines. Tidal Energy: various sources, concept of power generation, advantages, disadvantages, hurdles in its utilization

Unit Number: 5 **No. of Lectures: 3** **Title:** Geothermal Energy

Content Summary: Geothermal Energy, various sources, concept of power generation, advantages, disadvantages, hurdles in its utilization

Unit Number: 6 **No. of Lectures: 4** **Title:** Bioenergy

Content Summary: Biomass Conversion Routes- Combustion, Gasification, Anaerobic Digestion, Pyrolysis, , Digesters-fixed and floating digester biogas plants ,Case studies of Biomass systems for thermal applications and Power generation,

Unit Number: 7 **No. of Lectures: 3** **Title:** Hydrogen and Fuel Cells

Content Summary: Hydrogen as a fuel, properties of hydrogen, hydrogen utilization in Fuel Cells, Types of fuel cells, magneto hydrodynamic power generations.

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Fuel Cell energy storage systems. Ultra Capacitors. Bio-Mass and Bio-Fuels, environment concerns of conventional source of energy.

13.Books Recommended:

Text Books:

1) Non Conventional Energy Recourses - B.H Khan

2) Renewable Energy – Godfrey Boyle

Reference Books:

1) Renewable energy sources and emerging technologies by D.P.Kothari,K.C.Singhal, P.H.I.

2) Renewable Energy Technologies /Ramesh & Kumar /Narosa

Reference websites:

1. http://www.eia.gov/energyexplained/?page=renewable_home
2. http://www.renewableenergyworld.com/index/tech.html

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	COs covered
1.	• Outline the tutorial objectives and tutorial work plan • Outline the evaluation and marking scheme • Explaining course outcomes(Cos) • Introductory topics of the subject • Energy needs of India, and energy consumption patterns • Solar radiation and its measurement, scope, applications	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Tutorial Sheet 1, Doubt clearance	CO1

2.	• Wind speed and power relation • Tidal Energy • Geothermal Energy • Gasification, Anaerobic Digestion	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO2
	Minor Test		
3.	• Wind power systems • Biomass Conversion Routes-Combustion, • Quiz	• Tutorial Sheet 3, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO3
4.	Self-study topics: Fuel Cell energy storage systems. Ultra Capacitors. Bio-Mass and Bio-Fuels, environment concerns of conventional source of energy. • Case studies/real life examples	• Tutorial Sheet 4, Doubt clearance • Assignment (Discussion and presentation on self-study topics by the students and addressing the problems given in assignment) • Through discussion, Presentation or video demonstration	CO3 CO4

Practical Content

Sr. No.	Title of the Experiment	Performance based/ study based experiments	Unit covered	Time Required
1.	demonstrations of state-of-the art renewable energy activities occurring on campus (e.g., "solar cell roofs").	Study based	All	90 min
2.	written reports detailing their renewable energy systems concepts inclusive of preliminary results.	Study based	All	90 min
3.	design/analysis exercises related to synthesizing renewable energy systems, inclusive of a conceptual design seed	Study based	All	90 min

	project.			
4.	develop conceptual design solutions for effectively using renewable energy systems based upon prescribed scenarios.	Study based	All	90 min
5.	demonstrations of state-of-the art renewable energy activities occurring on campus (e.g., "solar cell roofs").	Study based	All	90 min
6.	written reports detailing their renewable energy systems concepts inclusive of preliminary results.	Study based	All	90 min
7.	Distributed Generation, Smart Grids	Study based	All	90 min
8.	Solar cities, Energy parks	Study based	All	90 min
9.	Low Carbon development	Study based	All	90 min

1.	**Lab Project(To be allotted at the start of the semester)**	Software based, to be done individually or in groups	Semester

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Vibration and Noise Engineering	**3. Course Code**	**4. L- T-P**	**5. Credits**
	MEL-625-MD	2-0-2	3
6. Type of Course (Check one):	Programme Core ☐	Programme Elective ✓	Open Elective ☐
7. Frequency of offering (check one):	Odd ☐	Even ☐	Either semester ✓	Every semester ☐

8. Brief Syllabus: Fundamentals of vibration; Vibration of single DOF systems: free vibrations, damped vibrations, forced vibration; Vibration of multi-DOF systems; Determination of natural frequencies and mode shapes: Dunkerley's formula, Rayleigh's method, Lagrange's equation, Holzer's method, Standard Eigen value problem, Continuous systems; Methods of vibration control: design of vibration isolators, auxiliary mass systems including tuned & untuned dampers for vibration control; Experimental methods for vibration testing. Fundamentals of noise; Noise sources; Noise level measurement, instrumentation and test techniques; Noise in vehicles, structural noise etc.; Control measures using mufflers, barriers, enclosures, vibration & noise reduction by active control etc.

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28 hours	**Tutorials: ----**	**Practice: 28 hours**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Describe the physical characteristics of vibrations and noise
CO 2	Formulate and solve the equations of motion for one, two and multi-DOF vibration systems.
CO 3	Calculate the natural frequencies and mode shapes of one, two and multi DOF mechanical systems.
CO 4	Implement different methods of vibration control.
CO 5	Suggest and apply appropriate strategies for control measures regarding exposure to noise

11. UNIT WISE DETAILS No. of Units: 6

Unit Number: 1 No. of Lectures: 2 Title: Fundamentals

Content Summary: Basic Concept, Applications, Terminology, Vibrating motion (periodic, oscillatory, harmonic, critically damped).

Unit Number: 2 No. of Lectures: 7 Title: Vibration of Single DOF System

Content Summary: Vibration model, Equation of motion-Natural Frequency, Energy method, Rayleigh method, Principle of virtual work, Damping models, Viscously damped free vibration, Logarithmic decrement, Determination of damping coefficient, Forced harmonic vibration, Magnification factor, Transmissibility, Equivalent viscous damping, Sharpness of resonance.

Unit Number: 3 No. of Lectures: 6 Title: Vibration of Multi-DOF System

Content Summary: Derivation of equations of motion for two and higher DOF systems, Forced harmonic vibration, influence coefficient method, flexibility and stiffness matrices, reciprocity theorem, Undamped and damped modal analysis, Torsional Vibration of simple, geared and branched systems.

Unit Number: 4 No. of Lectures: 4 Title: Determination of Natural Frequencies and Mode Shapes

Content Summary: Dunkerley's formula, Rayleigh's method, Lagrange's equation, Holzer's method, Standard Eigen value problem, Continuous systems, Natural frequency of simple mechanical system in 1 and 2-D cases.

Unit Number: 5 No. of Lectures: 3 Title: Methods of Vibration Control

Content Summary: Methods of vibration control: design of vibration isolators, auxiliary mass systems including tuned & untuned dampers for vibration control; Experimental methods for vibration testing.

Unit Number: 6 No. of Lectures: 6 Title: Noise

Content Summary: Fundamentals of noise; Noise sources; Noise level measurement, instrumentation and test techniques; Noise in vehicles, structural noise etc.; Control measures using mufflers, barriers, enclosures, vibration & noise reduction by active control etc.

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Determination of Natural Frequencies and Mode Shapes.

13. Books Recommended :

Text Books:

1. Rao, S. S., "Mechanical Vibrations", 5th edition, Pearson Education, 2010

2. Grover, G. K., "Mechanical Vibrations", 8th edition, Nem Chand & Bros, 2009.

Reference Books:

1. Ambekar, A.G., "Mechanical Vibrations and Noise Engineering", Prentice Hall India Learning Private Limited, 2006.

2. Norton M. P., Karczub D. G., "Fundamentals of Noise and Vibration Analysis for Engineers", 2nd edition, Cambridge University Press, 2003.

Reference websites:

http://nptel.ac.in/courses/112103112/

http://nptel.ac.in/downloads/112104040

https://engineering.purdue.edu/~deadams/ME563/notes_10.pdf

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	Cos covered
1.	• Outline the tutorial objectives and tutorial work plan • Outline the evaluation and marking scheme • Explaining course outcomes(Cos) • Numerical problems based on different Single DOF vibration systems • Numerical problems based on different multi DOF vibration systems	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Tutorial Sheet 1,2 • Doubt clearance	CO2
2.	• Outline the tutorial objectives and tutorial work plan • Outline the evaluation and marking scheme • Explaining course outcomes(Cos) • Numericals on determination of natural frequencies and mode shapes • Numericals on determination of natural frequencies and mode shapes	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Tutorial Sheet 3,4 • Doubt clearance	CO3
3.	• Presentation	• Experimental methods for vibration testing	CO4
Minor Test			
4.	• Presentation	• presentations on case studies of Vibration control	CO4
5.	• Video	• vibration reduction by active control etc. • Noise measure in vehicles, brakes, structural noise etc	CO5
6.	• Discussion & Presentation	• On research paper	All CO's

Practical Content

Sr. No.	Title of the Experiment	Software/Kit based/Component based	Unit covered	Time Required
1.	Find out different mode shapes of vibration of cantilever beam/shaft using OROS	**Software based**	**2,3**	**90 min**
2.	Find out natural frequency of cantilever beam/shaft using OROS	**Software based**	**4**	**90 min**

1.	**Mini Project**	Projects on vibration model of a practical system (Analytical, Fabrication & Software modeling)	Semester

COURSE TEMPLATE

1. Department:	**Mechanical Engineering**		
2. Production and Operation Management	**3. Course Code**	**4. L- T- P**	**5. Credits**
	Code: MEL570	2-1-0	3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☑ Open Elective ☐		
7. Frequency of offering (check one): Odd ☐ Even ☑ Either semester ☐ Every semester ☐			

8. Brief Syllabus: Production and Operations function- Production systems, Product Strategy and integrated product development, Process planning, Capacity Planning, Facilities Location Strategies, Methods study and Work Measurement, Line balancing, Group Technology, Cellular Manufacturing, Flexible manufacturing system, Aggregate production planning, Master Production Scheduling, Shop Scheduling and Shop Floor Control; Inventory control- JIT purchasing, Lead-time control; value flow and application of VSM, QFD; Maintenance Planning and Management- Corrective, Preventive and Predictive maintenance; Manpower Scheduling- Techniques of manpower scheduling, Service Operations Management.

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28 hours	**Tutorials: 14 Hours**	**Practical: --**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Students should be able to understand the production & operation management, Line balancing and Methods study and work measurement.
CO 2	Students should be able to know the Group Technology, Cellular Manufacturing, Flexible manufacturing system and Aggregate production planning and further apply these skills to understand the real time case studies.
CO 3	Students able to understand the scheduling, Inventory control, JIT purchasing and Maintenance Planning and Management.
CO 4	Students develop ability to solve the Techniques of manpower scheduling, Service Operations Management.

11. UNIT WISE DETAILS No. of Units: ___5_____

Unit Number: 1 No. of Lectures: 4 Title: Introduction to Production and Operations management

Content Summary: Production and Operations function- Production systems, Product Strategy and integrated product development, Process planning, Capacity Planning, Facilities Location Strategies

Unit Number: 2 No. of Lectures: 4 Title: Methods study

Content Summary: Methods study and Work Measurement, Line balancing

Unit Number: 3 No. of Lectures: 3 Title: Group Technology

Content Summary: Group Technology, Cellular Manufacturing, Flexible manufacturing system, Aggregate production planning

Unit Number: 4 No. of Lectures: 6 Title: Scheduling

Content Summary: Master Production Scheduling, Shop Scheduling and Shop Floor Control; Inventory control- JIT purchasing, Lead-time control; value flow and application of VSM, QFD

Unit Number: 5 No. of Lectures: 4 Title: Maintenance and Service

Content Summary: Maintenance Planning and Management- Corrective, Preventive and Predictive maintenance; Manpower Scheduling- Techniques of manpower scheduling, Service Operations Management

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Detailed study of rapid prototyping and tooling with case-studies

13. Books Recommended :
(b). Text Books:

1. Panneerselvam., “Production and Operations Management”, 3rd Edition, PHI Learning Pvt. Ltd, 2012.

2. J.P. Saxena., “Production and Operations Management”, 2nd Edition, McGraw Hill Education, 2009.

(c). Reference Books:

1) Chary, S.N., “Production and operations management”, Tata McGraw-Hill Education, 2012.

(d). Reference Website:

14. www.nptel.com

The practice part will have following components

Sr. No.	Practical/Tutorial/Activity	Description of Practice	CO Covered	Unit Covered	Time Required
1.	Discussion	Case study about traditional and modern production & operation management	CO1	Unit 1	**100 min**
2.	Discussion	Case study about operation strategies	CO2	Unit 2	**100 min**
3.	Discussion	Group discussion about scheduling	CO2	Unit 2	**100 min**
4.	Discussion	Real time case study about Shop Floor Control	CO2	Unit 3	**100 min**
5.	Discussion	Group discussion about the JIT, lead time control	CO2		**100 min**
6.	Problem Solving	Objective questions of types of Maintenance Planning and Management	CO2	Unit 4	**100 min**
7.	Discussion	Discussion about capacity planning with an example	CO2	Unit 4	**100 min**
8.	Discussion	Case study about traditional and modern production & operation management	CO2,CO3	Unit 5	**100 min**
9.	Discussion	Case study about operation strategies	CO1, CO2	Unit 1,2,3,4,5	**100 min**
10.	Presentation/Discussion	Student ppt and research paper presentation, case study discussion	CO3	Unit 6	**100 min**
11.	Presentation/Discussion	Student ppt and research paper presentation, case study discussion	CO3	Unit 6	**100 min**
12.	Presentation/Discussion	Student ppt and research paper presentation, case study discussion	CO4	Unit 7	**100 min**
13.	Lecture	Expert Lecture	CO3	Unit 6	**100 min**
14.	Test	Class Test	CO1-CO4	All Units	**100 min**

1.	**Lab Project(To be allotted at the start of**	Study based project report to be submitted in	Semester

	the semester)	comprehensive manner	

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Vehicle Development & Testing	**3. Course Code**	**4. L-T- P**	**5. Credits**
	Code: MEL 418	2 - 1- 0	3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ✓ Open Elective ☐		
7. Frequency of offering (check one): Odd ☐ Even ☐ Either semester ✓ Every semester ☐			
8. Brief Syllabus: Introduction to vehicle development: Vehicle development cycle; Introduction to vehicle and regulations: Vehicles classification; International standards in automotive industry, Test facility: engine test cell, water conditioning, air conditioning and test rigs; Types of dynamometers and selection; Cardan shafts; Engine tests and procedures in automotive industry: durability testing, reliability testing; Combustion measurement: In cylinder pressure measurement and other combustion parameters, components of in cylinder pressure measurement; Chassis dynamometer testing: types of chassis dynamometer testing; Emission Norms; Driving cycles: Indian and European; Emission tests and measurement: HC, CO and NO_X			
9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)			
Lectures: 28 hours	**Tutorials: 14**	**Practice: 0**	

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Understand the process of vehicle development and classification of vehicles
CO 2	Demonstrate a basic understanding of engine testing instruments, their selection and operation
CO 3	Knowledge about the engine tests and procedures done in industries
CO 4	Demonstrate a basic understanding of emission measuring instruments and operation
CO 5	Understand the basic classification of vehicles and testing
CO 6	Demonstrate a basic understanding of engine testing instruments, their selection and operation

11. UNIT WISE DETAILS No. of Units: ___6___

Unit Number: 1 No. of Lectures: 9 Title: Introduction to Vehicle Development

Content Summary: Introduction to idea of vehicles, Styling and aesthetics of vehicles, Phases in vehicle development

Unit Number: 2 No. of Lectures: 7 Title: Vehicles and Regulations

Content Summary: Classification of vehicles (including M, N and O layout), regulations overview (ECE, EEC, FMVSS, AIS, CMVR, ADR), specifications of vehicles & engines

Unit Number: 3 No. of Lectures: 7 Title: Engine Testing Facilities

Content Summary: Test cells, Dynamometers: Types and working, Cardan shafts: selection of cardan shaft, Air and water conditioning, instrumentation for temperature, pressure and flow.

Unit Number: 4 No. of Lectures: 6 Title: Engine Tests in Automotive Industry

Content Summary: Understanding Durability Testing; Reliability; Durability; In-Cell Testing; Increasing the Severity of the Test; Thermal Stress; Thermal Shock Testing; Combining Bench Testing with In-Field or Trials Testing; Test Duration and Engine Life Comparison

Unit Number: 5 No. of Lectures: 7 Title: Chassis Dynamometer Testing

Content Summary: Road load equation, chassis dynamometer setup and components, chassis dynamometer for emission testing, mileage testing, special purpose testing

Unit Number: 6 No. of Lectures: 4 Title: Emission Measurement and Test Procedures

Content Summary: Indian and European emission norms**,** Indian driving cycle, European driving cycle, Emission Test, Measurement of CO, CO_2, by NDIR, Hydrocarbon by FID – Chemiluminescent detector for NOx measurement, Smoke meters – Dilution tunnel technique for particulate measurement, Procedures on Engine and Chassis Constant Volume Sampling procedures, Sampling probes and valves, Quantifying emissions.

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Government policies, testing procedures and regulations, testing systems, Emission measurement procedures, **Lab Project**

13. Books Recommended :
Text Books:

1. Ganesan V.,"Internal Combustion Engines", 4th Edition, McGraw Hil Education, 2012
2. Martyr J. and Plint M A, “Engine Testing: Theory and Practice”, 4 th Edition, Elsevier Science, 2012
3. Bosch, "Automotive Handbook", 9th Edition, Robert Bosch GmbH, 2014

Reference Books:

1. Martyr J. and Plint M A, “Engine Testing: Theory and Practice”, 4 th Edition, Elsevier Science, 2012
2. Atkins Richard D., “An Introduction to Engine Testing and Development”, SAE International, 2009

Reference websites:

www.saeinternational.com

The practice part will have following components

Problem solving

Sr. No.	Topic	Mode	Cos covered
1.	• Numerical on engine performance and testing	• Tutorial sheet	CO2
2.	• Numerical on engine performance and testing • Quiz	• Tutorial sheet	CO2

Practical Content

Sr. No.	Title of the Experiment	Experimental / Self Study	Unit covered	Time Required
1.	Study of Fuel Measurement systems	**Experimental**	**3**	**90 min**
2.	Study of Air Measurement systems	**Experimental**	**3**	**90 min**
3.	Study of Eddy Current Dynamometer	**Experimental**	**3**	**90 min**
4.	Study of Di Gas Analyzer	**Experimental**	**3**	**90 min**
5.	Study of Engine Mounting systems	**Experimental**	**3**	**90 min**
6.	Study of Engine Test Cell	**Self-Study**	**3**	**90 min**
7.	Study of Fuel Injection System	**Experimental**	**3**	**90 min**
8.	Study of Engine Combustion Measurement	**Experimental**	**3**	**90 min**
9.	Performance Testing of an SI Engines	**Experimental**	**3,4**	**90 min**

10.	Performance Testing of an CI Engines	**Experimental**	**3,4**	**90 min**
11.	Emission Measurement of SI Engines	**Experimental**	**6**	**90 min**
12.	Emission Measurement of CI Engines	**Experimental**	**6**	**90 min**

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Automotive Safety	**3. Course Code**	**4. L-T- P**	**5. Credits**
	Code: MEL 613 AE	2 -0- 2	3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☑ Open Elective ☐		
7. Frequency of offering (check one): Odd ☐ Even ☐ Either semester ☑ Every semester ☐			
8. Brief Syllabus: Introduction to Automotive safety, motivation for automotive safety and Indian safety legislation, Indian accidental data, Automotive Safety Regulations, Global NCAP; Vehicle Collision: Mechanics of vehicle collision; Crash tests, crash test dummies, evaluation of crash tests; guidelines for design and evaluation of a good occupant restraint system**;** Accident Avoidance: Introduction to accidental avoidance, Human factors, comfort and ergonomics, Active Safety Systems: ABS, Traction Control, Electronic Stability Program, Adaptive cruise control, Lane departure warning, Brake by wire, Hill start assist control system, Pre-Crash safety; Passive Safety Systems: Vehicle compartment, Passive Safety Systems: Restraint systems, seatbelts, airbags, collapsible steering column; Automotive Safety Systems: Case studies of safety systems used by Automotive manufacturers: Concept of 360^0 Safety, Volvo safety systems, Mercedes Benz Safety systems, Integrated safety systems, Advanced Driver Assistance Systems; Crashworthiness, Crash energy management: parameters and structures, crumple zone, energy absorption bars; survival space			
9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)			
Lectures: 28 hours	**Tutorials: ---**	**Practice: 28 hours**	

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Demonstrate an understanding of vehicle and passenger safety
CO 2	Knowledge about the safety systems used in vehicles and their operation
CO 3	Knowledge about the analysis of vehicle safety and crash testing of vehicles

11. UNIT WISE DETAILS No. of Units: ___6___

Unit Number: 1 No. of Lectures: 3 Title: Introduction

Content Summary: Introduction to Automotive safety, motivation for automotive safety and Indian safety legislation, Indian accidental data, Automotive Safety Regulations, Global NCAP

Unit Number: 2 No. of Lectures: 6 Title: Vehicle Collision

Content Summary: Mechanics of vehicle collision; Crash impact tests, crash test dummies, evaluation of crash tests; guidelines for design and evaluation of a good occupant restraint system

Unit Number: 3 No. of Lectures: 5 Title: Accident Avoidance

Content Summary: Introduction to accidental avoidance: Human factors, comfort and ergonomics; Active Safety Systems: ABS, Traction Control, Electronic Stability Program, Adaptive cruise control, Lane departure warning, Brake by wire, Hill Assist, Pre-Crash Safety

Unit Number: 4 No. of Lectures: 4 Title: Occupant & Pedestrian Protection

Content Summary: Vehicle compartment, Passive Safety Systems: Restraint systems, seatbelts, airbags, collapsible steering column

Unit Number: 5 No. of Lectures: 5 Title: Automotive Safety Systems

Content Summary: Case studies of safety systems used by Automotive manufacturers: Concept of 360^0 Safety, Volvo safety systems, Mercedes Benz Safety systems, Integrated safety systems, Advanced Driver Assistance Systems

Unit Number: 6 No. of Lectures: 3 Title: Crashworthiness and Crash Energy Management

Content Summary: Crashworthiness, Crash energy management: parameters and structures, crumple zone, energy absorption bars; survival space

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Active Safety Systems, Passive safety Systems, FEA, **Lab Project**

13. Books Recommended :

Text Books:

1. Seiffert Ulrich and Wech Lothar ,"Automotive Safety Handbook", 2 nd Edition, SAE 2007
2. Rao Lakshmana C., Simha K. R. Y., and Narayanamurthy V.,"Applied Impact Mechanics", Ane Books Pvt. Ltd., 2015
3. "Vehicle Crashworthiness and Occupant Protection", American Iron and Steel Institute 2000

Reference Books:

1. Peters George A. and Peters Barbara J., "Automotive Vehicle Safety" CRC Press, 2002

Reference websites:

http://www.globalncap.org/

http://www.euroncap.com

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	Cos covered
1.	• Study on causes of accidents and accident prevention	• Self-Study and group discussion	CO 1,2
2.	• Study on types of Crash Test Dummies • Quiz	• Study on types of Crash Test Dummies	CO 3
3.	• Numerical problems on Impact mechanics	• Tutorial Sheet	CO 3
4.	• Numerical problems on Impact mechanics	• Tutorial Sheet	CO 3
5.	• Study of Safety systems used in vehicles	• Self-Study and assignment	CO 1,2
Minor Test			
6.	• Presentation by students	• Self-Study	CO 1,2,3
7.	• Presentation by students	• Self-Study	CO 1,2,3
8.	• Presentation by students	• Self-Study	CO 1,2,3
9.	• Presentation by students	• Self-Study	CO 1,2,3
10.	• Presentation by students	• Self-Study	CO 1,2,3

Practical Content

Sr. No.	Title of the Experiment	Software/Kit based/Component based	Unit covered	Time Required
1.	Impact Modelling	**Software based**	**2**	**90 min**

2.	Impact Modelling	**Software based**	**2**	**90 min**
3.	Impact Modelling	**Software based**	**2**	**90 min**
4.	Impact Modelling	**Software based**	**2**	**90 min**

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Introduction to FEM	**3. Course Code**	**4. L- T- P**	**5. Credits**
	Code: MEL510	2-0-2	3
6. Type of Course (Check one):	Programme Core ☑	Programme Elective ☐	Open Elective ☐
7. Frequency of offering (check one):	Odd ☑	Even ☐	Either semester ☐ Every semester ☐

8. Brief Syllabus: Linear algebra: matrix operations, numerical solution of linear matrix equations; Elasticity theory: strain-displacement and stress-strain relations, temperature effects, St. Venant's principle; Discretization (1-D and 2-D), Stiffness matrix, FEM equation for simple elements (bar, truss, beam, frame, and CST elements), assembling of elements, boundary conditions, nodal solutions; Coordinate systems, Shape functions, Consistant loads, Variational equation for deriving K; Heat conduction equations, FEM formulation in 2-D conduction problems; Practical points in using FEM software (Types of analysis, Meshing, Post-processing, Non-linear analysis)

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28 hours	**Tutorials: ---**	**Practice: 28 hours**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Explain the basics of Finite element method including its advantages and relevance to engineering and industrial applications.
CO 2	Derive stiffness matrix for 1 and 2 dimensional elements
CO 3	Assemble discrete elements to form the global FEM matrix equation for simple 1-D or 2-D problems
CO 4	Use FEM software for analysis of simple structural/thermal problems

11. UNIT WISE DETAILS No. of Units: ___7_____

Unit Number: 1 No. of Lectures: 1 Title: Introduction to FEM

Introduction to FEM, Advantages, disadvantages and applications

Unit Number: 2 No. of Lectures: 2 Title: Mathematical basics

Content Summary: Matrix operations, solution of linear matrix equations

Unit Number: 3 No. of Lectures: 4 Title: Basics of elastic theory

Content Summary: Definition of stress and strain, strain-displacement and stress-strain relations, plane stress and plane strain, temperature effects, St. Venant's principle

Unit Number: 4 No. of Lectures: 12 Title: FEM procedure

Content Summary: Discretization (1-D and 2-D), stiffness matrix, FEM equation for simple elements (bar, truss, beam, frame, and CST elements), assembling of elements, boundary conditions, nodal solutions

Unit Number: 5 No. of Lectures: 2 Title: Developing element equations

Content Summary: Coordinate systems, Shape functions, Consistant loads, Variational equation for deriving K

Unit Number: 6 No. of Lectures: 5 Title: Using FEM software

Content Summary: Types of analysis, Geometric modeling, Meshing, Boundary conditions, Post-processing, Nonlinear analysis

Unit Number: 7 No. of Lectures: 2 Title: FEM for heat conduction problems

Content Summary: Heat conduction equations, FEM formulation in 2-D conduction problems, Modeling of conduction problems in FEM software

12. Brief Description of Self-learning component by students (through books/resource material etc.):

The students will practically learn how to use FEM software by doing mini-projects.

13. Books Recommended :

Text Books:

Bhavikatti, S.S., "Finite Element Analysis", 3rd edition, New Age International Publishers, 2015.

Reference Books:

1) Gokhale, N.S., et al., "Practical Finite Element Analysis", Finite To Infinite, 2008.

2) Logan, D., "A First Course in the Finite Element Method", 5th edition, Cengage Learning India, 2012.

Reference websites:

http://www.nptel.ac.in/courses/112106135/2

The practice part will have following components

Sr. No.	Topic	Cos covered
1.	Numericals on matrix operations and solving systems of equations	2,3
2.	Numericals on stress and strain analysis	2
3.	Numericals on stress and strain analysis	2
4.	Numericals on bar elements	3
5.	Numericals on truss elements	3
6.	Numericals on beam and frame elements	3
7.	Numericals on CST elements	3
8.	Exercises on coordinate system and shape functions generation	2
9.	Start working with FEM software	4
10.	Software analysis of a cantilever beam under static loading	4
11.	Software analysis of a truss under static loading	4
12.	Software analysis of Steady state heat conduction in 2-D	4
13.	Clearing doubts and solving problems on selected topics	all

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Mechatronics	**3. Course Code**	**4. L-T-P**	**5. Credits**
	Code: MEL627-MD	2- 0-2	3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☑ Open Elective ☐		
7. Frequency of offering (check one): Odd ☐ Even ☐ Either semester ☑ Every semester ☐			

8. Brief Syllabus: Introduction to mechatronic systems and their components, Integrated design issues in Mechatronics Design Process and its factors and its key elements, Conceptual design, Possible design solutions for Mechatronics systems, Traditional approach vs. Mechatronics approach, Choice of sensors and actuators for any Mechatronics application, Smart sensors, Field buses, Logic gates, Programmable Logic Controllers and its programming, Selection of PLC for any application.

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28 hours	**Tutorials: ---**	**Practice: 28 hours**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Categorize traditional systems and Mechatronic systems.
CO 2	Plan and design possible solutions for a Mechatronic approach.
CO 3	Select proper sensors and actuators for a Mechatronic application.
CO 4	Write a PLC program for a particular application.

11. UNIT WISE DETAILS No. of Units: ___5_____

Unit Number: 1 No. of Lectures: 9 Title: Introduction to Mechatronics

Introduction to Mechatronic systems and their components, Integrated design issues, its factors and its key

elements, Traditional approach vs. Mechatronic approach

Unit Number: 2 **No. of Lectures: 7** **Title:** Design approach

Content Summary: Conceptual design, Possible design solutions for Mechatronic systems, example: wind screen wiper motion, switch, robotic movement, case studies etc.

Unit Number: 3 **No. of Lectures: 7** **Title:** Sensors and signal conditioners

Content Summary: Sensors and its types based upon application, smart sensors, operational amplifiers and its types, filters and its types, numerical

Unit Number: 4 **No. of Lectures: 6** **Title:** Actuators

Content Summary: hydraulic and pneumatic actuators, mechanical and electrical actuators with its different applications.

Unit Number: 5 **No. of Lectures: 7** **Title:** Introduction to PLC

Content Summary: Introduction to PLC, Selection of PLC for any given application, write a PLC program

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Traditional design approach, applications of basic sensors for displacement and motion, mechanical actuators.

13. Books Recommended :

Text Books:

Bolton, W., "Mechatronics", 6th edition, Pearson Education, 2015

Reference Books:

Mahalik N.P., "Mechatronics: Principles, Concepts & Applications", McGraw Hill Education, 2003

Reference websites:

http://nptel.ac.in/courses/112103174/

The practice part will have following components

Sr. No.	Topic	Cos covered
1.	Data acquisition using computer	2
2.	Transient response of first order system	2

3.	Possible design solutions for Mechatronic systems	1
4.	Determination & analysis of frequency response of second order RLC system.	3
5.	Study of process control system with P, PI and PID system	4
6.	Numerical on logic gates	2
7.	Quiz 1 on Mechatronic systems	1
8.	PLC programming using timers and counters for pick and place set-up	4
9.	Numerical on Operational amplifiers and its types	4
10.	Quiz 2 on op-amps and filters	4
11.	Study of PLC static panels	4
12.	Study of a PLC based industrial application	4
13.	Presentations on traditional approaches towards Mechatronic systems	1 & 2
14.	Presentations on recent developments in the applications of Mechatronic systems	3 & 4

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**			
2. Course Name: Quality Assurance and Reliability Engineering		**3. Course Code**	**4. L-T- P**	**5. Credits**
		Code: MEL460	2-1-0	3
6. Type of Course (Check one):	Programme Core ☐	Programme Elective ☑	Open Elective ☐	
7. Frequency of offering (check one):	Odd ☐	Even ☑	Either semester ☐	Every semester ☐

8. Brief Syllabus: Definition of Quality, the world Quality Gurus, Introduction to Control charts. Control chart for variables and attributes. Process capability analysis; statistical tolerance design and Selective assembly systems, Introduction to 6 Sigma, Cost of quality, Costs of Quality, Kaizen, 5S, Benchmarking. Acceptance Sampling, Sampling Plans, ISO 9000. Quality Circles, 7 QC tools, Advanced 7 QC tools Quality Function Deployment, National Quality Award Model Framework, Reliability & testing. Failure models of components, MTBF / MTTR / OEE, redundancy, Maintainability and Availability, TPM, Total Quality Management, Manufacturing Quality vs Service quality.

Practice (P): Quality related **case studies**, Quality **problem practices, application** of QC tools taught in the course to the Major project as a mini project / assignment with 10% weightage. An interactive teaching on key topics of Kaizen/ QC circles / Six sigma / introduction to DOE by industry expert and a group assignment on a special quality topics to be presented in the semester end with 15% weightage.

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28 hours **Practice: 28 hours/ batch**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Understand the basic Quality Concepts , 7QC tools and quality improvement techniques relevant to Industry.
CO 2	Solve quality related Problems and define suitable counter measures in a structured manner.
CO 3	Understand & analyze advance Quality concepts: SQC, 6-sigma, Sampling, Reliability & other new techniques.
CO 4	Apply Quality tools and techniques to real life cases.

11. UNIT WISE DETAILS No. of Units: ___7____

Unit Number: 1 No. of Lectures: 2 Title: Introduction to Quality and Quality Gurus

Introduction to quality and its continued relevance and importance in industry. What is Quality? The Quality gurus and their contribution.

Unit Number: 2 No. of Lectures: 6 Title: Seven QC tools, SQC, Sampling and Six Sigma

Content Summary: The 7 QC tools, the advanced QC tools, control charts (X-R, P and C charts), Attributes Vs Variable charts, inferences from control charts, random and assignable causes, numericals, Process capability, 6 sigma & dabbalwala.

Unit Number: 3 No. of Lectures: 4 Title: Kaizen, Quality Circles and five S (Industry Expert)

Content Summary: Continuous improvement and its needs, Kaizen Vs Innovation, the importance of Kaizen culture in industry, the role of Quality circles in industry and its related details, the foundation of improvement – 5S an its needs, Advanced 7 QC tools.

Unit Number: 4 No. of Lectures: 2 Title: Quality award models and the quality grid

Content Summary: The quality assessment characteristics, the importance of recognizing quality institutions, the different models – Deming, MBNQ, European, Australian, CII, UPTU etc quality models and the learnings. The Quality grid model and its understanding

Unit Number: 5 No. of Lectures: 6 Title: Quality function deployment (QFD), Benchmarking & COPQ

Content Summary: What is QFD ,how to apply the QFD tool, its relevance in today's world of new product launch, its applicability in service sector and practice sessions. Cost of quality and its characteristics.

Unit Number: 6 No. of Lectures: 5 Title: Reliability, Availability and Maintainability

Content Summary: Definitions, MTBF, MTTR, OEE, elements of maintainability, TPM, numericals

Unit Number: 7 No. of Lectures: 3 Title: TQM and ISO.

Content Summary: ISO certification and its elements, TQM and its elements, TQM vs ISO. Service quality and its relevance in today's world.

12. Brief Description of Self-learning component by students (through books/ resource material etc.):

- Self -learning through **group assignment** (10% weightage in marks) on a defined topic in the semester beginning followed with a presentation in semester end. Questions from the topics shall find place in the major exams.
- Self-learning by individual students on the application of the quality tools learnt (15% weightage in marks) in

the course and used in the major project.

13. Books Recommended :

Text Books:

1. Clifford F. Gray, Erik W. Larson and Gautam V. Desai., “Project Management- The Managerial Process”, 6th Edition, McGraw Hill Education, 2014.

Reference Books:

1. Jack R. Meredith, Samuel J. Mantel Jr., Scott M. Shafer., “Project Management- The Managerial Approach”, 9th Edition, Wiley Publication, 2014.

Reference websites:

http://asq.org/learn-about-quality/quality-tools.html
http://videos.asq.org/home

https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwig7pfE8PrSAhWMOo8KHZsGCsEQtwIIGzAA&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D-K-QIwXoGHE&usg=AFQjCNGlBieyN7EQlvPEi0AJ_cUvgWOXDw

The practice part will have following components

Practice No.	Practical/Tutorial/Activity	Description of Practice	Unit Number Covered
1	Tutorial / activity	Case study 1 highlighting application of 7QC tools in real life	2
2	-do-	Case study 2 highlighting Quality related application.	2
3	-do-	Application of Kaizen and QCC by industry experts	3
4	-do-	Practice session on the usage of Control charts	2
5	-do-	-do-	2
6	-do-	Application of Cp and CpK concepts	2
7	-do-	Exercise on QFD	5

8	-do-	Class group exercise on Benchmarking	5
9	-do-	Exercise on Sampling plan / OCC construction	7
10	-do-	Not decided	-
11	-do-	Interaction with industry experts	4
12	-do-	Group assignment/mini project presentations and assessment	-
13	-do-	Group assignment/mini project presentations and assessment	-
Details of Mini Project:			
Integrated it through group assignment on special topics and individual application of QC tools in major project. It would come in major exam.			

Minor Test:

Unit No. 1-4 shall be convered for Minor Test. A certain amount of flexibility on the topics is given to the faculty taking this course.

COURSE TEMPLATE

1. Department:	**Mechanical Engineering**		
2. Supply Chain Management	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL412	2-1-0	3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☐ Open Elective ✓		
7. Frequency of offering (check one): Odd ✓ Even ☐ Either semester ☐ Every semester ☐			

8. Brief Syllabus:- SCM – Need, Conceptual model, evolution, approach – traditional and modern, logistics, inbound and outbound, 3PL, 4PL, vendor relationships, elements of L&SCM, Global supply chain perspectives – Drivers, challenges, risk, Demand forecasting, methods, inventory management, , bull whip effect, inventory costs, EOQ, VMI, Role of SCM in JIT, lean management, Agile, mass customization, aggregate planning, Warehousing – types, functions, strategy, Transportation – elements, importance, modes, multi modal, containerization, Fleet management – process, factors, Distribution strategies – Cross docking, milk run, direct shipping, hub and spoke model, Role of IT in SCM – need, Tools, application in SCM, Internet, data mining, use of IT in warehousing, customer service etc., RFID,GPS,GIS, supply chain collaboration, Decision support system in SCM, Performance measures – internal and external, activity based costing, benchmarking, balance score card.

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28 hours	**Tutorials:14**	**Practice: 0**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Students should be able to understand the traditional & the modern supply chain system and global supply chain perspectives.
CO 2	Students should be able to know the importance of logistics management, Transportation infrastructure, Demand & Inventory and further apply these skills to understand the real time case studies.
CO 3	Students able to understand the distribution of product and methods of distribution according to application.
CO 4	Students able to understand role of information technology in supply chain management
CO 5	Students develop the ability to relate and implement learning from supply chain system to

	industries and higher research.

11. UNIT WISE DETAILS No. of Units: ___5_____

Unit Number: 1 No. of Lectures: 4 Title: Introduction to supply chain management

Content Summary: SCM – Need, Conceptual model, evolution, approach – traditional and modern, logistics, inbound and outbound, 3PL,4PL, elements of L&SCM

Unit Number: 2 No. of Lectures: 5 Title: Demand and Inventory

Content Summary: Content Summary: 2. Demand forecasting, methods, supply chain strategy, inventory management, inventory costs, EOQ, JIT, lean management, mass customization, aggregate planning, VMI, bull whip effect, vendor relationships

Unit Number: 3 No. of Lectures: 5 Title: Warehousing and Distribution

Content Summary: Content Summary: Warehousing – types, functions, strategy; Transportation – elements, importance, modes, multi modal, containerization Distribution strategies – Cross docking, milk run, direct shipping, hub and spoke model

Unit Number: 4 No. of Lectures: 5 Title: Role of SCM in Information Technology

Content Summary: Role of IT in SCM – need, Tools, application in SCM, Internet, APS, data mining, use of IT in warehousing, customer service etc., RFID,GPD,GIS, supply chain collaboration, Decision support system in SCM

Unit Number: 5 No. of Lectures: 5 Title: Performance measurement of SCM

Content Summary: Performance measures – internal and external, activity based costing, benchmarking, SCOR modelling, balance score card.

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Self learning of the RFID,GPS,GIS, Supply chain collaboration with the help of online sources NPTEL etc.

13.Books Recommended:

a). Text Books:

1. D K Agrawal, "Textbook of Logistics and Supply Chain Management", Macmillan, 2003.

(b). Reference Books:

1. Sunil Chopra and Peter Meindl, "Textbook: Supply Chain Management: Strategy, Planning and Operation", Fourth edition, Prentice-Hall, Inc., 2010.

(c). Reference Website: www.nptel.com

The practice part will have following components

Sr. No.	Practical/Tutorial/Activity	Description of Practice	CO Covered	Unit Covered	Time Required
1.	Discussion	Case study about traditional & modern supply chain management and Global supply chain (International case study)	CO1	Unit 1	**100 min**
2.	Discussion	Case study about logistic development	CO2	Unit 2	**100 min**
3.	Problem Solving	Solving the numerical problems in economic order quantity (EOQ)	CO2	Unit 2	**100 min**
4.	Problem Solving	Real time case study about bull whip effect	CO2	Unit 2	**100 min**
5.	Discussion	Group discussion about the JIT, lean management	CO2	Unit 2	**100 min**
6.	Group work	Group activity for the distribution strategies – Cross docking, milk run, direct shipping, hub and spoke model	CO2	Unit 3	**100 min**
7.	Problem Solving	Objective questions of types of warehousing and its functions	CO3	Unit 3	**100 min**
8.	Discussion	Case study about the Role of information technology in supply chain management	CO4	Unit 4	**100 min**
9.	Discussion	Discussion about using of SCOR modelling and balance score card with an example	CO5	Unit 1,2,3,4,5	**100 min**
10	Presentation	Student ppt and research paper presentation	CO3	Unit 6	**100 min**

11	Presentation	Student ppt and research paper presentation, case study discussion	CO3	Unit 6	**100 min**
12	Presentation/Discussion	Student ppt and research paper presentation, case study discussion	CO4,CO5, CO6	Unit 7	**100 min**
13	Lecture	Expert Lecture	CO3	Unit 6	**100 min**
14	test	Class Test	CO1-CO5	All Units	**100 min**

1.	**Lab Project(To be allotted at the start of the semester)**	Integrated it through group assignment on special topics and individual application of SCM in major project. It would come in major exam.	Semester

COURSE TEMPLATE

1. Department:	**Mechanical Engineering**		
2. Course Name:Advanced Manufacturing Processes	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL530	2-1-0	3
6. **Type of Course (Check one):**	Programme Core ☑	Programme Elective ☐	Open Elective ☐

7. Books Recommended :

1. "Materials and Processes in Manufacturing" (8th Edition), E. P. DeGarmo, J. T Black, R. A. Kohser, Prentice Hall of India, New Delhi (ISBN 0-02-978760).

2. "Manufacturing Science" A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.

3. "Nontraditional Manufacturing Processes", G.F. Benedict, Marcel Dekker, Inc. New York (ISBN 0-8247-7352-7

8. **Frequency of offering (check one):** Odd ☐ Even ☑ Either semester ☐ Every semester ☐

9. Brief Syllabus:

Advanced Machining Processes-Introduction, Process principle, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes; Advanced Casting Processes- Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting; Advanced Welding Processes- Types of welding, LBW, EBW, Thermit, Flash, Friction & Resistance; Advanced Metal Forming- - Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming, Contour roll forming; Rapid Prototyping and Rapid tooling- principle of Rapid Prototyping (RP) and Rapid tooling, comparison with conventional machining processes, various techniques for RP

Practicals (Pn): Lab visits to understand the advanced machining processes, Casting & welding Processes, metal Forming and Unconventional machining process. Industrial Exposure in the form of Expert Lecture/Industry Tour

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 42	**Tutorials:14**	**Practicals (P_n): 0**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Able to Learn the advanced machining process: applications and fundamentals of all unconventional processes.
CO 2	Able to learn the Casting & welding processes.
CO 3	Able to learn the advance metal forming processes and apply these skills in real time environment.
CO 4	Able to understand the concepts and importance of Rapid Prototyping and Rapid tooling

11. UNIT WISE DETAILS No. of Units: 05

Unit Number: 1 No. of Lectures: 6 Title:Advanced Machining Processes

Content Summary: Introduction, Process principle, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes

Unit Number: 2No. of Lectures: 6 Title:Advanced Casting Processes

Content Summary: Casting Design, patterns and allowances, preparation of sand, Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting

Unit Number: 3No. of Lectures: 6 Title: Advanced Welding processes

Content Summary: Details of electron beam welding (EBW), laser beam welding (LBW); ultrasonic welding (USW), Friction Stir welding, Thermit welding, Flash welding, Spot Welding, Seam Welding and Projection welding.

Unit Number: 4No. of Lectures: 5 Title: Advanced Metal Forming Processes

Content Summary: Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming, Contour roll forming

Unit Number: 5No. of Lectures: 5 Title:Rapid Prototyping & Rapid Tooling

Content Summary: Introduction, Process principle of Rapid Prototyping (RP) and Rapid tooling, comparison with conventional machining processes, various techniques for RP; Stereo -lithography processe, Selective laser sintering (SLS), Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM), 3-D Ink-Jet Printing

12. Title of Lab. Manual, if applicable:

13. Brief Description of Self-learning components by students (through books/resource material etc.): Additional study material (books/websource):

- Shaw M.C. 1996, Principles of Abrasive Processing, Oxford University Press
- Hassan El-Hofy,2007, Fundamentals of Machining Processes, CRC Press, Taylor & Francis Group.
- P.K. Mishra, 2007, Nonconventional Machining, Narosa publishing House.
- nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/.../LM-35.pdf
- Collection of review and research chapters on Non-Conventional processes: Editors: Davim, Jao Paulo, Year 2013-http://www.springer.com/gp/book/9781447151784

14. Details of Practical (Pn):MEL530– Advanced Manufacturing Processes

S.No.	Activity Description	Unit Covered
1	Parameteranalysis of Abrasive jet machining (AJM), Water jet machining (WJM) with an example	1
2	Parameteranalysis of Electrochemical machining (ECM), Electro discharge machining (EDM)with an example	1
3	Parameteranalysis ofElectron beam machining (EBM), Laser beam machining (LBM) processes with an example	1
4	Lab visit for understand traditional and advanced Casting processes and types	2
5	Lab visit for understand traditional and advanced Welding processes and types	2
6	To understand the parameter analysis of electron beam welding (EBW), laser beam welding (LBW) and ultrasonic welding (USW)	2
7	Group discussion about the types of Metal Forming Processes	3
8	Assignment for list of application of Electro-magnetic forming, explosive formingprocess	3
9	PPT presentation on Unconventional machining process	4
10	Applications and fundamentals of all unconventional processes	4
11	Objective type of questions in Rapid Prototyping and Rapid tooling	5
12	Assignment in types of techniques in Rapid Prototyping	5

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan.

COURSE TEMPLATE

1. Department:	MECHANICAL ENGINEERING		
2. Course Name: Advance Heat & Mass Transfer	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL 550	2-1-0	3
6. **Type of Course (Check one):**	Programme Core ☑ Programme Elective ☐ Open Elective ☐		
7. Pre-requisite(s), if any (Mention course code and name)	MEL 290 THERMODYNAMICS MEL 202 HMT		

8. Books Recommended :

1. Frank P. Incropera "Fundamentals of Heat and Mass Transfer" ,Seventh Edition-2011, Wiley & Sons
2. by A Bejan, "Convection Heat Transfer", Fourth Edition-2013, Wiley & Sons

9. **Frequency of offering (check one):** Odd ☐ Even ☐ ☑ Either semester ☐ Every semester ☐

10. Brief Syllabus:

Recapitulation of laws governing heat & mass transfer; General conduction equation - in rectangular, cylindrical and spherical coordinates; Unsteady state conduction- large plane walls, cylinder and spheres; Heat transfer from extended surfaces- proper length of a fin; Multidimensional conduction; Numerical solution of conduction problems; Thermal radiation gray body radiation, radiation shields; Natural and forced convection; Heat exchangers- effectiveness-ntu; Phase Change heat transfer- flow boiling and film condensation; Special topics in heat transfer.

Pn: Numerical on heat exchangers, case studies and presentations.

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures:28	**Tutorials:**14	**Pn:**

11. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Recapitulation of physical laws governing heat transfer.
CO 2	To solve unsteady state heat conduction problems.

CO 3	To analyze heat transfer through fins
CO 4	To solve free, forced & phase change convection problems
CO 5	To analyze heat transfer in a shell and tube heat exchanger
CO 6	To analyze heat transfer due to thermal radiation
CO 7	To analyze mass diffusion problems

12. UNIT WISE DETAILSNo. of Units: 5

Unit Number: 1 No. of Lectures: Title: Basic laws of Heat & Mass transfer

Content Summary: Recapitulation of basic Laws of heat & mass transfer

Unit Number: 2No. of Lectures: Title: Unsteady State Heat Conduction

Content Summary: General conduction equation in Cartesian, cylindrical and spherical coordinates, Lumped system analysis, transient heat conduction in large plane walls, long cylinders and spheres, semi infinite solids and multi dimensional heat conduction, Heat transfer through extended surfaces, Governing equation, Numerical methods in heat conduction.

Unit Number: 3No. of Lectures: Title: Convection & Heat exchangers

Content Summary: Newton's law of cooling, Convective heat transfer coefficient; Free and forced convection and associated correlations; Differential convection equation; dimensionless equation, thermal boundary layer; Reynolds analogy, Various dimensionless numbers: Reynolds, Prandtl, Nusselt, Grashoff; Overall heat transfer coefficient, Convection with unheated starting length, laminar internal convection, turbulent internal convection, natural convection inside enclosures, combined natural and forced convection, phase change convection, heat exchangers analysis

Unit Number: 4No. of Lectures: Title: Thermal Radiation

Content Summary: Thermal radiation and properties; Laws governing radiation heat transfer, Shape factor; Heat transfer between surfaces, radiation shields.

Unit Number: 5No. of Lectures: Title: Mass transfer

Content Summary: Introduction; Flick's law of diffusion; steady state diffusion though a wall, Heat & mass transfer analogy, Mass convection

13. Title of Lab. Manual, if applicable:

14. Brief Description of Self-learning components by students (through books/resource material etc.):

15. **Details of Pn content:**

S.No.	Activity Description	Unit Covered

1	Experiment on parallel flow heat exchanger	3
2	Experiment on counter flow heat exchanger	3
3	Problems on steady state conduction with heat generation	1
4	Problems on transient conduction	2
5	Mid semester viva voce	-
6	Problems on convection	3
7	Problems on boiling & condensation	3
8	Problems on heat exchangers-1	3
9	Problems on heat exchangers-2	3
10	Problems on mass diffusion	5
11	Presentation on special topics in heat transfer	-
13	Presentation on special topics in heat transfer	-
14	End semester viva voce	-

COURSE TEMPLATE

1. Department:	**Mechanical Engineering**		
2. Course Name: Advanced Fluid Dynamics	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL580	2-0-2	3
6. **Type of Course (Check one):**	Programme Core [√] Programme Elective [ ] Open Elective [ ]		

7. Books Recommended :

i. Introduction of Fluid Mechanics: Fox &Mcdonald
ii. Introduction to Fluid Mechanics - by Ira M. Katz, James P. Schaffe
iii. Advanced Engineering Fluid Mechanics **–** K. Muralidhar, G. Biswas.

8. **Frequency of offering (check one):** [√] Odd Even [ ] Either semester [ ] Every semester

9. Brief Syllabus:(as printed in the Courses of study)

Recapitulation of basic laws of fluid flow in integral and differential form. Newtonian fluid flow. Governing equations for viscous fluid flows. Boundary layer theory. Fundamental of compressible flows. Introduction to numerical methods in fluid flows. Multiphase flows-an introduction.

Pn: Numerical, case studies and presentations.

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28	**Tutorials: 0**	**Pn: 28**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.

CO 1	Understand the fluid mechanics and fluid dynamics fundamentals
CO 2	Apply the numerical approaches
CO 3	Demonstrate an understanding of the relationships between fluid fundamentals and numerical approaches
CO 4	Prepare a written report on the simulation of fluid problems

11. **UNIT WISE DETAILSNo. of Units: 5**

Unit Number: 1 No. of Lectures: 6Title: Introduction

Content Summary:

Introduction to Computational Fluid Dynamics.

Unit Number: 2No. of Lectures: 6 Title: Principles of Conservation

Content Summary:

Continuity Equation, Navier-Stokes Equation, Energy Equation Energy Equation and General Structure of Conservation Equations.

Unit Number: 3No. of Lectures: 6 **Title:**Basic laws **Content Summary:** Governing equations for viscous fluid flows, numerical problems based on fluid flow, Boundary layer theory. Fundamental of compressible flows.
Unit Number: 4No. of Lectures: 6 **Title:**Fundamentals of Discretization **Content Summary:** Finite Element Method, Finite Difference and Finite Volume Method, Finite Volume Method.
Unit Number: 5No. of Lectures: 4 **Title:**Multiphase flows **Content Summary:** Introduction. to Multi-phase flow.
12. Title of Lab. Manual, if applicable: NIL
13. Brief Description of Self-learning components by students (through books/resource material etc.): Simple numerical problems on Basic laws etc.using numerical methods.

14. **Details of Tutorials:**

S.No.	Tutorial Description	Unit Covered
1	Numerical on Fluid Properties & Fluid Statics	1
2	Numerical on Fluid Properties & Fluid Statics	1
3	Numerical on Fluid Kinematics	2
4	Numerical on Fluid Kinematics	2
5	Numerical on Fluid Dynamics	3
6	Numerical on Fluid Dynamics	3
7	Numerical on Laminar Flow through pipes	4
8	Numerical on Laminar Flow through pipes	4
9	Numerical on Pipe fittings	5
10	Numerical on Pipe fittings	5
11	Numerical on Boundary Layer Flow	6

12	Numerical on Boundary Layer Flow	6
13	Numerical on Turbulent Flow	7
14	Numerical on Turbulent Flow	7

Details of Practical (Lab Experiments)

S.No.	Description of Experiments	Unit Covered
1	Introduction Lab Class	NA
2	Experiment on Meta-centric height.	1
3	Experiment on variable area flow meters.	3
4	Experiment on variable area flow meters.	3
5	Experiment on Notches.	3
6	Experiment on Notches.	3
7	Mid-Term Viva	NA
8	Experiment on Reynolds experiment.	4
9	Experiment on friction loss in pipes.	5
10	Experiment on pipe fittings.	5
11	Experiment on Stokes law.	6
12	End-Term Experiment & Viva	NA

COURSE TEMPLATE

1. Department:	MECHANICAL ENGINEERING		
2. Course Name: CFD & HT	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL 601TH	2-0-2	3
6. **Type of Course (Check one):**	Programme Core ☐ Programme Elective ☑ Open Elective ☐		
7. Pre-requisite(s), if any (Mention course code and name)	MEL 202 Heat & Mass transfer MEL 208 Fluid Mechanics		

8. Books Recommended :

1. Versteeg and Malasekra," An introduction to CFD", Second Edition, Pearson.

2. Patnakar S.V. "Numerical Heat transfer and Fluid Flow ", Taylor and Francis.

9. **Frequency of offering (check one):** Odd ☐ Even ☑ Either semester ☐ Every semester ☐

10. Brief Syllabus:

Basic equations of Fluid flow and Heat Transfer; Classification of governing equations, Boundary conditions; Discretisation methods, finite difference method, finite element method and finite volume method; Finite volume method for diffusion & diffusion-convection problems; SIMPLE algorithm and flow field calculations, variants of SIMPLE; Turbulence and turbulence modeling; Numerical method for radiation heat transfer.

Pn: Numerical on cfd, case studies and presentations.

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28	**Tutorials:** 0	**Pn:** 28

11. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Physical interpretation of governing equations & Boundary conditions.
CO 2	Finite difference method. Finite volume method. Finite element methods.
CO 3	Turbulence & its modelling.

CO 4	Solution algorithm for pressure-velocity coupling in steady flows
CO 5	Solution of dicretisation equations

12. UNIT WISE DETAILSNo. of Units: 5

Unit Number: 1 No. of Lectures: 6Title: Recapitulation

Content Summary: Governing equations of Fluid flow and Heat Transfer, classification of governing equations, boundary conditions.

Unit Number: 2No. of Lectures: 8 Title: Turbulence & its modelling

Content Summary: Characteristics of simple turbulent flows, Reynolds-averaged Navier Stokes (RANS) models, Large Eddy Simulation (LES), Direct Numerical Simulation (DNS).

Unit Number: 3No. of Lectures: 8 Title: Discretisation methods

Content Summary: Finite difference method, Finite element methods, Finite volume method, Finite volume method for diffusion & diffusion-convection problems

Unit Number: 4No. of Lectures: 4 Title: Pressure velocity coupling

Content Summary:SIMPLE algorithm and flow field calculations, variants of SIMPLE

Unit Number: 5No. of Lectures: 2 Title: Numerical solution of radiation heat transfer

Content Summary: Numerical method for radiation heat transfer.

13. Title of Lab. Manual, if applicable:

14. Brief Description of Self-learning components by students (through books/resource material etc.): PPTs and LMS

15. **Details of Pn content:**

S.No.	Activity Description	Unit Covered
1	Exact solution of fluid flow & heat transfer problems-1	3
2	Exact solution of fluid flow & heat transfer problems-2	3
3	Exact solution of fluid flow & heat transfer problems-3	1
4	Numerical solution of pure diffusion problem	2
5	Numerical solution of diffusion-convection problem-1	-
6	Numerical solution of diffusion-convection problem-2	3

7	Mid semester viva voce	3
8	Presentation on special topics in heat transfer	3
9	Presentation on special topics in heat transfer	3
10	Project	5
11	Project	-
13	Project	-
14	End semester viva voce	-

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan.

COURSE TEMPLATE

1. Department:	Mechanical		
2. Course Name: Design for Manufacturing and Assembly	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL603-MD	2-1-0	3
6. **Type of Course (Check one):**	Programme Core ☐ Programme Elective ☐ ✔Open Elective ☐		

7. Books Recommended :

- Geoffrey Boothroyd, Peter Dewhurst and Winston Knight (2002) Product Design for Manufacture and Assembly, Second Edition, CRC press, Taylor & Francis, Florida, USA.
- D. E. Whitney, (2004) Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development, Oxford University Press, New York.
- M. F. Ashby, "Materials Selection in Mechanical Design" Butterworth Heinemann, 1999.
- NPTL online course "Design for Manufacture and Assembly (DFMA)", by Prof. Abinash K. Swain, IIT Guwahati, http://nptel.ac.in/courses/107103012.

8. **Frequency of offering (check one):** ☐ Odd ☐ Even ✔Either semester ☐ Every semester

9. Brief Syllabus:

History, advantages, and importance of DFMA; Role of DFM in product specification and standardization; Steps for applying DFMA during product design; Methods of material, shape and process selection;Design for various processes (casting and moulding, powder processing, machining, cold working, sheet metal working, surface polishing and coating); Design for quality and reliability; Robust design approaches; Design approaches for assembled products and assembly systems (Economics of assembly, Taxonomy of assembly operations, Entity Relationship Diagram, Assembly sequence analysis, Liaison diagram, Guidelines for design for assembly)

Practical (Pn): Case studies on design for manufacturing and assembly; Solving sample problems; Presentations by students on selected topics

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28	**Tutorials: 14**	**Practicals (P): 0**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Explain the importance and advantages of implementing DFMA methods.
CO 2	Apply the basic guidelines of DFM during product design
CO 3	Apply basic methods of design for quality and reliability during product design
CO 4	Explain the basics of robust design (Taguchi's methods).
CO 5	Apply design approaches for assembled products and assembly systems

11. UNIT WISE DETAILSNo. of Units: 6

Unit Number: 1 No. of Lectures: 3Title: Role of DFM and steps to apply it

Content Summary:

History, advantages, and importance of DFMA. Role of DFM in product specification and standardization. Steps for applying DFMA during product design.

Unit Number: 2No. of Lectures: 5 Title: Methods of material, shape and process selection

Content Summary:

Processes classification and their attributes; Steps of selection; Material-process-shape relations; Selection of shape; Selection of materials; Selection of process

Unit Number: 3No. of Lectures: 5 Title: Design for various processes

Content Summary:

Design for casting and moulding processes: sand casting, investment casting, die casting, injection moulding, powder processing; Design for machining: turning, drilling and boring, milling, grinding; Design for cold working: forging, extrusion, stamping; Design for sheet metal working; Design for surface polishing and coating: Cleaning of surfaces, polishing, electroplating, hot dip coating, spray coating, vacuum coating, surface heat treatment

Unit Number: 4No. of Lectures: 5 Title: Design for quality and reliability

Content Summary:

Introduction to Failure Mode and Effect Analysis (FMEA), Steps to implement FMEA, Importance of design for quality (DFQ), Strategies to implement DFQ, Definition of reliability (DFR), Strategies to implement DFR

Unit Number: 5No. of Lectures: 4 Title: Robust Design

Content Summary:

Introduction to robust design approach (Taguchi method); The problem with traditional measures of Quality; Design using Orthogonal arrays

Unit Number: 6No. of Lectures: 6 Title: Design approaches for assembled products and assembly systems

Content Summary:

Economics of assembly, Taxonomy of assembly operations, Entity Relationship Diagram, Assembly sequence analysis, Liaison diagram, Guidelines for design for assembly (effect of part symmetry, effect of thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, etc.)

12. Title of Lab. Manual, if applicable: Nil

13. Brief Description of Self-learning components by students (through books/resource material etc.):

14. **Details of Practical (Pn):**

S.No.	Activity Description	Unit Covered
1	Case studies on how DFMA can be applied	1
2	Case studies on how DFMA can be applied	1
3	Case studies on how DFMA can be applied	1
4	Solving sample problems on material, shape and process selection	2
5	Solving sample problems on material, shape and process selection	2
6	Case studies on material, shape and process selection	2
7	Solving sample problems on design for quality and reliability	4
8	Solving sample problems on design for quality and reliability	4
9	Case studies on design for quality and reliability	4
10	Case studies on design for quality and reliability	4
11	Case studies on robust design	5
12	Case studies on robust design	5
13	Solving sample problems on design of assembly systems	6
14	Case studies on design of assembly systems	6

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan.

COURSE TEMPLATE

1. Department:	Mechanical Engineering		
2. Course Name: Advanced Mechanics of Solids	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL-607-MD	2-1-0	3
6. **Type of Course (Check one):**	Programme Core ☐ Programme Elective ☑ Open Elective ☐		

7. Books Recommended :

Richards Jr., R., "Principles of Solid Mechanics", CRC Press.

Boresi and Schmit, "Advanced Mechanics of Materials", John Wiley & Sons.

8. **Frequency of offering (check one):** ☑ Odd ☐ Even ☐ Either semester ☐ Every semester

9. Brief Syllabus:

3-D analysis of stress. 3-D analysis of strain and deformation. Constitutive Relations (Generalized Hooke's law, 3-D stress-strain relation for linear elastic Isotropic solids, Compatibility equations). Mechanical Behavior of Solids (Role of experiments in solid mechanics; Elastic material behavior; Plastic material behavior; Visco-elastic material behavior). 2-D elasticity boundary value problems (Plane stress deformation, plane strain deformation, St. Venant's principle, stress concentration problems). Rayleigh, Euler-Bernoulli and Timoshenko beam theories. Torsion of open and closed hollow beams. One-Dimensional Plasticity (Plastic Bending, Plastic "Hinges", Limit Load (Collapse) of Beams)

Practical (Pn): 1. Case study related to elastic material behaviour. 2. Case study related to Plastic material behavior. 3. Case study related to Visco-elastic material behavior. 4. Case study related to boundary value problems. 5. Case study related to Rayleigh beam. 6. Case study related to Euler-Bernoulli beam theory. 7. Case study related to Timoshenko beam theory. 8. Presentation by students related to the topics of the course (They should read research paper and explain to the class).

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28	**Tutorials: 14**	**Practicals (P): --**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Explain the 3-D stress and strain states and their relationship in linear elastic isotropic solids.
CO 2	Define the elastic, plastic, and visco-elastic deformation behaviors of materials and explain the role of different experiments to identify these behaviors.

CO 3	Formulate 2-D elasticity boundary value equations for a given problem.
CO 4	Explain the Rayleigh, Euler-Bernoulli and Timoshenko beam theories, their differences, and their applications.
CO 5	Calculate the stress and strain in open and closed hollow beams under torsion.
CO 6	Explain the basics and applications of one-dimensional plasticity.

11. UNIT WISE DETAILSNo. of Units: 6

Unit Number: 1 No. of Lectures: 6Title: 3-D stress and strain

Content Summary:

3-D analysis of stress. 3-D analysis of strain and deformation. Generalized Hooke's law. 3-D stress-strain relation for linear elastic Isotropic solids. Compatibility equations.

Unit Number: 2 No. of Lectures: 3 Title:Mechanical Behavior of Solids

Content Summary:

Role of experiments in solid mechanics; Elastic material behavior; Plastic material behavior; Visco-elastic material behavior; Analysis of the tensile test

Unit Number: 3 No. of Lectures: 8 Title: 2-D elasticity boundary value problems

Content Summary:

Plane stress deformation, plane strain deformation, St. Venant’s principle, stress concentration problems

Unit Number: 4 No. of Lectures: 4 Title: Beam theories

Content Summary:

Rayleigh, Euler-Bernoulli and Timoshenko beam theories: assumptions, formulations, and applications

Unit Number: 5 No. of Lectures 4 Title: Torsion of open and closed hollow beams

Content Summary:

Elementary (Linear) Solution for circular cross-sections, Prandtl’s Stress Function, Membrane Analogy, Thin-Walled Tubes of Arbitrary Shape

Unit Number: 6 No. of Lectures: 3 Title: One-dimensional plasticity

Content Summary:

Plastic Bending, Plastic “Hinges”, Limit Load (Collapse) of Beams

12. **Details of Practical (Pn):**

S.No.	Activity Description	Unit Covered
1	Numericals on elastic material behaviour.	2
2	Numericals on elastic material behaviour.	2
3	Numericals on Plastic material behavior	2
4	Case study on Plastic material behavior	2
5	Case study on Visco-elastic material behavior.	2
6	Case study on Visco-elastic material behavior.	2
7	Case study on boundary value problems.	3
8	Numericals on boundary value problems.	3
9	Numericals on Rayleigh beam.	4
10	Case study on Rayleigh beam.	4
11	Numericals on Euler-Bernoulli beam theory.	4
12	Case study on Euler-Bernoulli beam theory.	4
13	Numericals on Timoshenko beam theory.	4
14	Case study on Timoshenko beam theory.	4

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan.

COURSE TEMPLATE

1. Department:	**Mechanical Engineering**		
2. Course Name: Concurrent Engineering	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL-609-IP	2-0-2	3
6. **Type of Course (Check one):**	Programme Core ☐	Programme Elective √	Open Elective ☐

7. Books Recommended :

- *Concurrent Engineering by Andrew Kusiak*
- *Concurrent Engineering fundamentals Integrated Product and Process Organization by Biren Prasad*

8. **Frequency of offering (check one):** √Odd ☐Even ☐Either semester ☐Every semester

9. Brief Syllabus:

Introduction to concurrent Engineering (CE)-Background, Definition and requirement, benefits of CE, Life cycle design of products, life cycle costs, Support for CE, Classes of support for CE activity, CE organizational, structure CE, team composition and duties, Necessary organizational changes; Design Product for Customer-Industrial Design, Quality Function Deployment, house of quality, Translation process of quality function deployment (QFD), Modeling of Concurrent Engineering Design, Compatibility approach, Compatibility index, implementation of the Compatibility model, integrating the compatibility concerns; Design for Manufacture-Introduction, role of DFM in CE, DFM methods, DFM guidelines, design for assembly, creative design methods, product family themes, design axioms, Taguchi design methods, Computer based approach to DFM; Quality by Design-Quality engineering & methodology for robust product design, parameter and Tolerance design, Taguchi's Quality loss function and signal to noise ratio for designing the quality, experimental approach; Design for reliability& Maintainability- design for economics, decomposition in concurrent design, concurrent design case studies.

Practical (Pn): Case studies & Numerical exercises on QFD, Taguchi's quality loss function and experimental design, Design for reliability and maintainability and other relevant topics to be conducted in the practical component.

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)		
Lectures: 28	**Tutorials:**	**Practical (P_n)-28**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	To Learn the basic concepts of Concurrent Engineering
CO 2	To understand the theory of QFD, Product Design and Design for manufacture
CO 3	To Learn the concepts of Design for Reliability
CO 4	To understand the importance of concurrent engineering in Industrial applications

11. UNIT WISE DETAILSNo. of Units: 05

Unit Number: 1 No. of Lectures: 4 Title: Introduction to Concurrent Engineering
Content Summary: Background, Definition and requirement, benefits of CE, Life cycle design of products, life cycle costs. Support for CE: Classes of support for CE activity, CE organizational, structure CE, team composition and duties, Necessary organizational changes.

Unit Number: 2 No. of Lectures: 6 Title: Design Product for Customer
Content Summary: Design Product for Customer: Industrial Design, Quality Function Deployment, house of quality, Translation process of quality function deployment (QFD). Modeling of Concurrent Engineering Design: Compatibility approach, Compatibility index, implementation of the Compatibility model, integrating the compatibility concerns.

Unit Number: 3 No. of Lectures: 6 Title: Design for manufacture
Content Summary: Design for Manufacture: Introduction, role of DFM in CE, DFM methods, DFM guidelines, design for assembly, creative design methods, product family themes, design axioms, Taguchi design methods, Computer based approach to DFM.

Unit Number: 4 No. of Lectures: 6 Title: Quality by Design
Content Summary: Quality engineering & methodology for robust product design, parameter and Tolerance design,
Taguchi's Quality loss function and signal to noise ratio for designing the quality, experimental approach

Unit Number: 5 No. of Lectures: 6 Title: Design for Reliability and maintainability
Content Summary: Design for reliability, basic concepts, design for maintainability, Life cycle serviceability,
design for economics, decomposition in concurrent design, concurrent design case studies

12. Title of Lab. Manual, if applicable:

13. Brief Description of Self-learning components by students (through books/resource material etc.):
Case studies and additional study material on concurrent engineering can be accessed from the following
Links: nptel.ac.in/courses/Webcourse-contents/IISc-BANG/.../mod8.pdf
http://onlinelibrary.wiley.com/doi/10.1111/1540-5885.1330229/abstract
http://www.southampton.ac.uk/~jps7/Lecture%20notes/Lecture%209%20Concurrent%20Engineering.pdf
https://www.researchgate.net/publication/229036499_Concurrent_Engineering-A_Case_Study_involving_University_and_Industry
http://www.vtt.fi/inf/pdf/publications/2010/P753.pdf.
http://onlinelibrary.wiley.com/doi/10.1111/1540-5885.1330229/abstract

14. Details of Practical (Pn):

S.No.	Activity Description	Unit Covered
1	Discussion on case study	1
2	Demonstration on stages of completion of a designing project adopting CS approach (exercise to be solved by students)	2
3	Numerical on QFD	2
4	Student présentation on application of Taguchi design methods	3
5	Class test 1	

6	Student presentation of DOE and Taguchi's loss function	4
7	Concurrent design case studies	5
8	Student presentation (Research paper)	2
9	Class test 2	
10	Student presentation (Research paper)	3
11	Student presentation (Research paper)	4
12	Student presentation (Research paper)	5
13	Class test 3	
14	Viva	

COURSE TEMPLATE

1. Department:	**Mechanical Engineering**		
2. Course Name: Product Life Cycle Management	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL-611-IP	2-0-2	3
6. **Type of Course (Check one):**	Programme Core ☐ Programme Elective ☐ Open Elective ✓ ☐		

7. Books Recommended :

John Stark, "Product Life Cycle Management-21st century paradigm for product realization" , Springer, 2015 edition.

8. **Frequency of offering (check one):** Odd ☐ Even ☐ Either semester ☐ ✓ Every semester ☐

9. Brief Syllabus:

Introduction to PLM-Definition, Scope, benefit, spread; The PLM Environment-Product data issues, complex changing environment, Product pains, product opportunities; Business process in the PLM environment- Introduction, process reality in a typical company, Business process activities in an PLM initiative; Product Data and process in PLM Environment- Reality in a typical company, Product data activities in the PLM initiative; Information system in the PLM Environment- Introduction to PLM applications, Application activities in the PLM initiatives, Best practice PDM selection system; Organizational change management in the PLM environment- Introduction, participants in change, OCM activities in PLM initiative; Project/program management in the PLM initiative- Introduction, PM activities in a PLM initiative. The PLM Initiative: Introduction, Approaches to PLM initiative, Case Studies.

Practical (Pn): Case studies, Group Discussions and presentations related to applications of PLM in Industries.

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28	**Tutorials:**	**Practicals:28**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	To Learn the basic concepts of Product Life Cycle Management
CO 2	To understand the PLM environment, Business processes, product data and associated role of PLCM
CO 3	To understand the role of PLCM in PLM activities and People integration,
CO 4	To Develop ability to integrate PLM learnings with product development and real life applications

CO 5	To Learn the basic concepts of Product Life Cycle Management

11. UNIT WISE DETAILSNo. of Units: 07

Unit Number: 1 No. of Lectures: 2 Title: Introduction to PLM

Content Summary: Definition, Scope, benefit, spread, PLM grid, Product Lifecycle phases, Pre-PLM Environment, PLM Paradigm, Benefits and Impact of PLM

Unit Number: 2 No. of Lectures: 4 Title: The PLM Environment

Content Summary:

Issues in traditional environment, Product data issues, Impact of Globalization, Changing business models, Complex changing environment, Regulation and compliance, Product pains, Product environment, Pre-emptive measures and PLM, Product opportunities, case study

Unit Number: 3 No. of Lectures: 4 **Title: Business process in the PLM environment**

Content Summary: Introduction, process reality in a typical company, Business process activities in an PLM initiative, Relevance in business in PLM, opportunity of growing market, Technology, social and environmental opportunity, case study

Unit Number: 4 No. of Lectures: 4 **Title: Product data and Process in PLM Environment**

Content Summary: Definition and Introduction, Product data across lifecycle, Organizing the product data, Product data a strategic resource, Importance of product data in PLM, Engineering change process, Product flow and product data, Process mapping and modeling, Hierarchical process structure, case study

Unit Number: 5 No. of Lectures: 3 **Title: Information systems in the PLM environment**

Content Summary:

Introduction to PLM applications, Reality in a typical company, Generic and specific PLM application, The PDM system, KPI's for PLM application, Generic issues, Interaction with company initiatives, Best practice PDM system selection, case study

Unit Number: 6 No. of Lectures: 3 **Title:Organizational change management in the PLM environment**

Content Summary:

Relevance of OCM in PLM, Benefits, Equation for change, Participants in change, OCM activities in the PLM initiatives, Overview of methods, Participants in the PLCM, activities in PLM initiative.

Unit Number: 7 No. of Lectures: 4 **Title:Project/program management in the PLM initiative** **Content Summary:** Introduction, PM activities in a PLM initiative, Project phases, Importance of PM in PLM, Generic issues with projects, KPI's for project management, Learning from experience, Middle managers and executives, Approaches to a PLM initiative, Standard approach and ten step approach, Pitfalls of PLM initiative, case study
12. Title of Lab. Manual, if applicable:
13. Brief Description of Self-learning components by students (through books/resource material etc.): PLM Case studies can be taken from following resources: http://www.lnttechservices.com/services/product-lifecycle-management-plm/case-studies/ http://www.plm.automation.siemens.com/en_in/about_us/success/industry-case-studies/index.cfm https://www.infosys.com/engineering-services/case-studies/Pages/aerospace-product-lifecycle-management.aspx White paper: titled, " ROI of PLCM" can be downloaded from, " http://www.concurrent-engineering.co.uk/plm-case-study-adidas"

Details of Practical (Pn) content:

S.No.	Experiment Description	Unit Covered
1	A Group Discussion on Benefits & applications of PLCM	1
2	Case Study/Group Discussion on PLCM structure	2
3	Assessment-1	
4	Case Study/GD on Emergence of PLCM	4
5	Group Exercise/Case Study/GD on role of PLCM in processes and product data	7,8
6	Group Exercise/Case Study/GD on role of PLCM in processes and product data	7,8
7	Case study on application of PLCM	9
8	Assessment-2	
9	Case study on application of PLCM	9
10	Group Discussion/Presentations on Change mgmt	9,10
11	Group Discussion/Presentations/ Case study on PM Environment/ New PLM	10,11

	softwares in market	
12	Assessment-3	
13	An expert session on latest PLM softwares	
14	Assessment-4	

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan.

COURSE TEMPLATE

1. Department:	**Mechanical Engineering**		
2. Course Name: PROJECT MANAGEMENT	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL 613-IP	2-0-2	3
6. **Type of Course (Check one):**	Programme Core ☐ Programme Elective √ Open Elective ☐		

7. Books Recommended :

- Project Management – The Managerial Process: Clifford F Gray, Erik W. Larson &Gautam V Desai.
- Project Management – A Managerial approach: Jack R. Meredith and Samuel J. Mantel.

8. **Frequency of offering (check one):** Odd ☐ Even ☐ Either semester √ Every semester ☐

9. Brief Syllabus:

Introduction to Project Management-Project Management vs. Ongoing Operations, project characteristics, common terms used in project, growing importance, steps & check points, phases in the project cycle, Project Types, Pure Project, Functional Project and Cross Functional or matrix structure; People aspects of Project- Project leader, Roles, responsibilities, authority, accountability, team structure, stake holders;Project Appraisal -Project Budgeting, Investment Planning, Pay back periods, ROI, IRR, NPV, project selection decisions; Project Network techniques - Work Breakdown Structure, Project Control Charts, GANTT charts, Network Planning Models, AOA & AON approach, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Floats, Network understanding, drawing and the analysis; Project software -Primavera software and its application; Project Crashing and leveling- Time-Cost Trade-off, Crashing, Resource loading and Leveling; Project Control and evaluation - Project Control and Evaluation Mechanisms, Project Time and Cost Overruns, Schedule / cost / Time / Resource variation over time; Project failure prevention**-** Causes of Project success &Failure,failure preventive measures, Case Studies Relating to Successful and Unsuccessful projects.

Practical (Pn): The tutorials shall consist of Case studies, numerical problems in Project appraisal and PERT/CPM related network**.**

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28	**Tutorials:**	**Practicals: 28**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Understand and demonstrate the basic elements of Project Management relevant to real life domain.

CO 2	Solve Project Appraisal decision making problems.
CO 3	Demonstrate / understand / analyze / represent projects using GANTT chart/ PERT / CPM approaches.
CO 4	Utilize the PM software s and demonstrate understanding of a holistic project journey.

11. UNIT WISE DETAILSNo. of Units: 08

Unit Number: 1 No. of Lectures: 5 Title: Introduction to Project Management

Content Summary: Project Management vs. Ongoing Operations, project characteristics, common terms used in project, growing importance, steps & check points, phases in the project cycle, Project Types: Pure Project, Functional Project and Cross-Functional or matrix structure.

Tutorials 1&2: Analysis of case studies

Unit Number: 2 No. of Lectures: 2 Title: People aspects of Project

Content Summary: Project leader, Roles, responsibilities, authority, accountability, team structure, stake holders.

Unit Number: 3 No. of Lectures: 4 Title: Project Appraisal

Content Summary: Project Budgeting, Investment Planning, Pay back periods, ROI, IRR, NPV, project selection decisions.

Unit Number: 4No. of Lectures: 6 Title: Project Network techniques

Content Summary: Work Breakdown Structure, Project Control Charts, GANTT charts, Network Planning Models; AOA & AON approach, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Floats, Network understanding, drawing and the analysis.

Unit Number: 5 No. of Lectures: 2 Title: Project software

Content Summary : Primavera software and its application

Unit Number: 6 No. of Lectures: 2 Title: Project Crashing and leveling:

Content Summary: Time-Cost Trade-off, Crashing, Resource loading and Leveling.

Unit Number: 7 No. of Lectures: 4 Title: Project Control and evaluation.

Content Summary: Project Control and Evaluation Mechanisms, Project Time and Cost Overruns, Schedule / cost / Time / Resource variation over time

Unit Number: 8 No. of Lectures: 3 Title: Project failure prevention

Content Summary: Causes of Project success &Failure,failure preventive measures, Case Studies Relating to Successful and Unsuccessful projects.

12. Title of Lab. Manual, if applicable:

13. Brief Description of Self-learning components by students (through books/resource material etc.):
Case studies on project management implementation:

http://www.pmsolutions.com/case-studies/

https://www.projectsmart.co.uk/case-studies.php

http://www.pmi.org/Business-Solutions/OPM3-Case-Study-Library.aspx

14. Details of Practical Content (Pn):

S.No.	Description of Experiments	Unit Covered
1	Project formulation case studies to share the project Charter and GANTT chart usage.	UNIT1
2	Case studies on successful and unsuccessful projects for analysis and understanding.	UNIT2
3	Numerical on Project appraisal – Pay back, ROI, IRR and NPV.	UNIT3
4	Project networking mapping using the restrictions / precedence list.	UNIT4
5	AOA approach (dummy activity) to map the network and work on the critical path.	UNIT 5
6	Quiz	
7	PERT network understanding/expected completion times/variance through numerical.	UNIT 6
8	AON approach to map the network and work on the critical path.	UNIT 7
9	Project Crashing with AON approach related problem solving.	UNIT 8
10	Resource leveling problem solving.	UNIT 9
11	Understanding and using the Primavera software.	UNIT 10
12	Utilizing all tools / technique on a comprehensive case-study.	UNIT 11
13.	Presentation of each team's PM assignment which uses all the techniques learnt.	UNIT 12
14	Quiz / Clarifications / any other unforeseen things.	UNIT 13/14

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan

COURSE TEMPLATE

1. Department:	**ME**		
2. Course Name: Manufacturing Economics and Costing	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEP 617 IP	2-0-2	3
6. **Type of Course (Check one):**	Programme Core ☐ Programme Elective ✓ Open Elective ☐		
7. Books Recommended : Phillip F. Ostwald, Timothy S. McLaren, "Cost Analysis and Estimating for Engineering and Management" Pearson/Prentice Hall, 2004.			
8. **Frequency of offering (check one):** Odd ☐ Even ☐ Either semester ✓ Every semester ☐			
9. Brief Syllabus: Manufacturing Economics- Introduction to manufacturing economics, principle and use of economic analysis, Estimating procedure, Methods of evaluation , Long and short term consequences, Capital budgeting, Replacement analysis, Decision making, Econometrics, Analysis of cost, Fixed cost, variable cost; Cash Flow- Introduction to Cash flows, Depreciation, Methods of depreciation, Discounted cash flows, Cost Benefit Analysis, Activity based costing and traditional cost allocation structure; Performance analysis- Analyzing performance by cost, Labor costing, Materials costing, Equipment and Tooling cost estimation, Evaluation of investment alternatives, Target costing, Case studies on cost estimation from manufacturing industries. **Practical (Pn):** Practical will consist of case studies and problem solving related to budgeting, replacement analysis, costing (labor, performance, equipment), cost benefit analysis.Case study on Capital budgeting, Case study on Replacement analysis, Case study on Decision making, Case study on Analysis of cost, Fixed cost, variable cost, Case study on Depreciation, Case study on Cost Benefit Analysis, Case study on Activity based costing, Case study on performance by cost, Case study on Labor costing, Materials costing, Case study on Equipment and Tooling cost estimation, Case study on Evaluation of investment alternatives, Target costing**,**			
Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)			
Lectures: 28	**Tutorials:**	**Practicals:14**	

10. Course Outcomes (COs) After completion of this course the students will be able to	
CO 1	Students will be able to carry out the cost calculations for manufacturing process.
CO 2	Will be able to decide about the processes based on cost estimation.

CO 3	Will be able to solve the problems related to cost estimation.

11. UNIT WISE DETAILSNo. of Units: 03

Unit Number: 1 No. of Lectures: 9Title:Manufacturing economics

Content Summary:

Introduction to manufacturing economics, principle and use of economic analysis, Estimating procedure, Methods of evaluation , Long and short term consequences.

Unit Number: 2No. of Lectures: 9Title:Cash flow

Content Summary:

Introduction to Cash flows, Depreciation, Methods of depreciation, Discounted cash flows, Cost Benefit Analysis, Activity based costing and traditional cost allocation structure

Unit Number: 3No. of Lectures: 10Title:Performance analysis

Content Summary:

Analyzing performance by cost, Labor costing, Materials costing, Equipment and Tooling cost estimation, Evaluation of investment alternatives, Target costing, Case studies on cost estimation from manufacturing industries.

12. Title of Lab. Manual, if applicable: NIL

13. Brief Description of Self-learning components by students (through books/resource material etc.): Case studies on: Practical will consist of case studies and problem solving related to budgeting, replacement analysis, costing (labor, performance, equipment), cost benefit analysis.

14.

S.No.	Description of Practicals	Unit Covered
1.	Case study on Capital budgeting	1
2.	Case study on Replacement analysis	1
3.	Case study on Decision making	1
4.	Case study on Analysis of cost, Fixed cost, variable cost	2
5.	Case study on Depreciation	2
6.	Case study on Cost Benefit Analysis	2

7.	Case study on Activity based costing	3
8.	Case study on performance by cost	3
9.	Case study on Labor costing, Materials costing	4
10.	Case study on Equipment and Tooling cost estimation	4
11.	Case study on Evaluation of investment alternatives, Target costing,	5

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan.

COURSE TEMPLATE

a. Department:	Mechanical Engineering		
b. Course Name: Composite Materials	**c. Course Code**	**4. L-T-Pn**	**5. Credits**
	MEL-617-MD	2 – 0 – 2	3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☐ ✔Open Elective ☐		

7. Books Recommended :

a) Robert M. Jones, "Mechanics of Composite Materials", Taylor & Francis Publishers

b) MadhujitMukhopadhyay, " Mechanics of Composite Materials and Structures",Universities Press Publishers

c) Srinivasan K., "Composite Material: Production Properties", Narosa Publishers.

d) Ever J. Barbero "Introduction to Composite Materials Design",CRC Press Publishers.

8. Frequency of offering (check one): ✔ Odd ☐ Even ☐ Either semester ☐ Every semester

9. Brief Syllabus:

Introduction: Definitions, History of Fibre Reinforced Composite, Constituent materials, Lamina and laminates, FRP, Properties & applications. Manufacturing of Composites: Using different moulding method. Micromechanical Analysis of Composite Strength and Stiffness: Introduction, Volume and weight fraction, Assumptions and limitations, Longitudinal strength and stiffness, Transverse modulus, Inplane shear modulus. Elastic Properties of the Unidirectional Lamina: Introduction, Stress-strain relationship, Stress-Strain relations of a thin lamina, Transformation of Stress, Strain & Elastic constants. Analysis of Laminated Composites: Laminates, Basic assumptions, Strain-Displacement Relationship, Stress-Strain relation, Equilibrium equations, Laminates stiffness, Determination of Lamina Stresses and Strains, Coupling effects, Types of Laminates configuration. Analytical Methods of Laminated Plate: Introduction, CLPT, Bending of Rectangular Plate, Shear deformation in laminated plates. Hygrothermal Effects in Laminates & Failure of composites: Introduction, Effect of Hygrothermal Forces on Mechanical behaviour, Micromechanics of Hygrothermal properties, Hygrothermoelastic Stress-Strain relations, Residual Stresses.

Practical (Pn): 1. To show video related to application of composite. 2. Explain the different manufacturing process of composite materials. 3. To find out the different parameter related to strength/ stiffness. 4. To find out the different stress and strain in composite. 5. Case study of lamina orientation in composite materials. 6. Case study related to CLPT. 6. Analytical analysis of Bending of rectangular plate. 7. Case study of hygrothermal effects on composites material. 8. Numerical analysis of failure of composites.

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures:28	**Tutorials:**0	**Practicals (Pn):**28

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Explain the properties and applications of composite materials
CO 2	Explain the manufacturing process of composite materials.
CO 3	Analyze the mechanical properties of laminated composites
CO 4	Explain the hygrothermal effects in laminates & failure of composites.

11. UNIT WISE DETAILSNo. of Units: 7

Unit Number: 1 No. of Lectures: 3**Title: Introduction to composites**

Content Summary:

Definitions, History of Fibre Reinforced Composite, Constituent materials, Lamina and laminates, FRP, Properties & applications.

Unit Number: 2No. of Lectures: 3**Title: Manufacturing of Composites**

Content Summary:

Using different moulding method.

Unit Number: 3No. of Lectures: 4 **Title: Micromechanical Analysis of Composite Strength and Stiffness**

Content Summary:

Introduction, Volume and weight fraction, Assumptions and limitations, Longitudinal strength and stiffness, Transverse modulus, Inplane shear modulus.

Unit Number: 4No. of Lectures: 4 **Title: Elastic Properties of the Unidirectional Lamina**

Content Summary:

Introduction, Stress-strain relationship, Stress-Strain relations of a thin lamina, Transformation of Stress, Strain & Elastic constants.

Unit Number: 5No. of Lectures: 5 **Title: Analysis of Laminated Composites**

Content Summary:

Laminates, Basic assumptions, Strain-Displacement Relationship, Stress-Strain relation, Equilibrium equations, Laminates stiffness, Determination of Lamina Stresses and Strains, Coupling effects, Types of Laminates configuration.

Unit Number: 6No. of Lectures: 4 **Title: Analytical Methods of Laminated Plate**

Content Summary: Introduction, CLPT, Bending of Rectangular Plate, Shear deformation in laminated plates.
Unit Number: 7 No. of Lectures: 5 **Title:Hygrothermal Effects in Laminates & Failure of composites** **Content Summary:** Introduction, Effect of Hygrothermal Forces on Mechanical behaviour, Micromechanics of Hygrothermal properties, Hygrothermoelastic Stress-Strain relations, Residual Stresses.

12. Details of Practical (Pn):

S.No.	Activity Description	Unit Covered
1.	To show video related to application of composite. (Video)	1
2.	Explain the different manufacturing process of composite materials. (Video)	2
3.	To find out the different parameter related to strength/ stiffness.(Tutorial)	3
4.	Numerical Based on volume & weight fraction	3
5.	To find out the different stress and strain in composite.(Tutorial)	4
6.	Numerical analysis of elastic properties of lamina	4
7.	Case study of lamina orientation in composite materials.(Case study)	5
8.	Case study related to CLPT. (Case study)	6
9.	Analytical analysis of Bending of rectangular plate. (Case study)	6
10.	Case study related to shear deformation in laminated plates. (Case study)	6
11.	Case study of hygrothermal effects on composites material. (Case study)	7
12.	Numerical analysis of failure of composites. (Tutorial)	7
13.	Anisotropic Strength and Failure Theories(Tutorial)	7
14.	Numerical based on stress-strain analysis of composite	7

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan.

COURSE TEMPLATE

1. Department:	Mechanical		
2.Course Name: Analysis of IC Engine Systems	3.Course Code	4.L-T-P	5.Credits
	MEL 621TH	2-1-0	3

6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☑ Open Elective ☐
7. Pre-requisite(s), if any (Mention course code and name)	Internal Combustion Engines

8. Books Recommended :

1. V. Ganesan,"Internal Combustion Engines",Fourth EditionMcGraw-Hill.
2. V. Ganesan,"Modeling of SI Engines",Fourth EditionMcGraw-Hill.
3. V. Ganesan,"Modeling of CI Engines",Fourth Edition McGraw-Hill.
4. J.B. Heywood, "Internal Combustion Engines",McGraw-Hill.

9. Frequency of offering (check one): Odd ☐ Even ☒ Either semester ☑ Every semester ☐

10. Brief Syllabus:

Recapitulation of fundamentals: Engines types, operation, performance parameters, air cycles, fuel injection systems, lubrication and cooling; Engine modeling: modeling of processes in SI and CI; Combustion: Combustion in SI and CI engines: Pressure vs crank angle diagrams, heat release rate, rate of pressure rise, mass fraction burned, and temperature profiles; Engine design for best performance and low emissions; Meeting present and future emission legislation; Engine testing: Instruments and operation, performance, emission measurement and analysis.

Pn: Numerical on performance, experiments and presentations.

Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28	**Tutorials:14**	**P: ---**

11. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Demonstrate a basic understanding of engine function, performance, and design methodology.
CO 2	Perform preliminary design of internal combustion engines for sizing of engines for particular application.

CO 3	Analyze thermodynamic cycles for Otto, Diesel and Dual cycles
CO 4	Determine and understand the effects of spark timing, valve timing, A/F ratio, engine geometry, fuel type, and manifold tuning on engine performance and emissions.
CO 5	Perform experiments on single cylinder engine with professional code and prepare a written report on the design and the performance and emissions analysis of an internal combustion engine.

12. UNIT WISE DETAILSNo. of Units: 4

Unit Number: 1 No. of Lectures:9Title:Introduction

Content Summary: Engines types, Operation, Performance parameters, Air cycles, Fuel injection systems, Lubrication, Cooling

Unit Number: 2No. of Lectures:9 Title: Engine Modelling

Content Summary: Modeling of engine processes such as intake, fuel injection and exhaust in SI and CI engine

Unit Number: 3No. of Lectures:6 Title: Combustion in SI and CI Engines

Content Summary: Combustion: Combustion in SI and CI engines, Pressure vs crank angle diagrams, Heat release rate, Rate of pressure rise, Mass fraction burned, Temperature profiles. Engine design for best performance and low emissions, Meeting present and future emission legislation,

Unit Number: 4No. of Lectures:5 Title: Engine Testing

Content Summary: Test cells, Dynamometers, Instruments for testing, Performance measurement, Emission measurement, Data analysis

13. Brief Description of Self-learning components by students (through books/resource material etc.):

1. **Power-point Presentations**
2. **LMS**

14. **Details of Practicals:**

S.No.	Tutorial Description	Unit Covered
1	Numerical problems on Engine performance Parameters	1
2	Numerical problems on Engine performance Parameters	1
3	Modelling of SI Engines	1
4	Modelling of SI Engines	2

5	Modelling of SI Engines	2
6	Modelling of CI Engines	2
7	Modelling of CI Engines	1,2,3
8	Modelling of CI Engines	4
9	To perform constant speed performance test of a dieselengine and prepare the curves (i) BP, v/s load (ii) brake specific fuel consumption v/sload	1
10	To perform variable speed performance tests of a two-stroke petrol engine and prepare the curves (i) bp, vs speed (ii) bsfc vsspeed	1
11	Measurement of exhaust emissions from from engine using AVL Digas Analyzer	1
12	Student presentations	
13	Student presentations	
14	Viva Voce	

Note: The above mentioned information is just a guideline and can vary as per course coordinator's course plan.

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Smart Manufacturing	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL-485	2-0-2	3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☑ Open Elective ☐		
7. Frequency of offering (check one):	Odd ☐ Even ☐ Either semester ☐ Every semester ☑		

8. Brief Syllabus: Introduction to Automation: Automated Manufacturing system; Need of automation, Basic elements of automation, Levels of automation, Automation Strategies, Advantages & disadvantages of automation, Historical development and Introduction to Industry 4.0. Fundamental of Numerical Control, elements of NC machine tools, classification of NC machine tools, Advantages, suitability and limitations of NC machine tools, Application of NC system. Definition and designation of control axes, Constructional details of Numerical Control Machine Tools, MCU structure and functions, Methods of improving accuracy and productivity using NC. Computer Numerical Control (CNC): Features of CNC, Elements of CNC machines, the machine control unit for CNC , Direct Numerical Control(DNC) and Adaptive Controls. System Devices: Drives, Feedback devices, Counting devices, DAC and ADCs, Interpolator systems, Control loop circuit elements in PTP system, Contouring system, Incremental and absolute systems. NC Part Programming- (a) Manual (word address format) programming Examples Drilling, Turning and Milling; canned cycles, Subroutine, and Macro. (b) Computer Assisted Part programming (APT) Geometry, Motion and Additional statements, Macro- statement. Computer Integrated manufacturing system, Group Technology, Flexible Manufacturing System, Computer aided process planning-Retrieval and Generative System. Types and generations of Robots, Structure and operation of Robot, Robot applications.

Practice (P): Tutorial sheets based on the topics, Case studies and presentations.

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 28	**Tutorials: ---**	**Practice: 28**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Describe the fundamentals of automation and its application.
CO 2	Describe the fundamentals of Numerical Control for increasing productivity
CO 3	Apply the Concept of Computer Numerical Control for manufacturing.
CO 4	Understand the basic concept of NC part programming
CO 5	Describe and apply the concept of CIM & Robotics.

11. UNIT WISE DETAILS **No. of Units: 5**

UNIT-I: Introduction to Automation

Automated Manufacturing system; Need of automation, Basic elements of automation, Levels of automation, Automation Strategies, Advantages & disadvantages of automation, Historical development and Industry 4.0.

UNIT-II: Numerical Control

Fundamental of Numerical Control, elements of NC machine tools, classification of NC machine tools, Advantages, suitability and limitations of NC machine tools, Application of NC system. Definition and designation of control axes, Constructional details of Numerical Control Machine Tools, MCU structure and functions, Methods of improving accuracy and productivity using NC.

UNIT -III: Computer Numerical Control (CNC)

Features of CNC, Elements of CNC machines, the machine control unit for CNC , Direct Numerical Control(DNC) and Adaptive Controls. System Devices: Drives, Feedback devices, Counting devices, DAC and ADCs, Interpolator systems, Control loop circuit elements in PTP system, Contouring system, Incremental and absolute systems.

UNIT -IV: NC Part Programming

(a) Manual (word address format) programming Examples Drilling, Turning and Milling; canned cycles, Subroutine, and Macro. (b) Computer Assisted Part programming (APT) Geometry, Motion and Additional statements, Macro-statement.

UNIT-V: CIM & Robotics

Computer Integrated manufacturing system , Group Technology, Flexible Manufacturing System, Computer aided process planning-Retrieval and Generative System. Types and generations of Robots, Structure and operation of Robot, Robot applications.

12. Brief Description of Self-learning component by students (through books/resource material etc.):
Manufacturing Systenm and its application. Computer aided manufacturing systems

13. Contextual learning component(s)

3D Printing

14. Books Recommended:

1. Automation, Production System and Computer Integrated Manufacturing, by Mikell P. Grover, Prentice Hall of

India Pvt Ltd.

2. CAD/CAM – Theory and Practice, by Ibrahim Zeid, McGraw Hill

3. Computer Aided Manufacturing, by Cheng, Pearson India

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	Cos covered
5.	• Outline the tutorial objectives and tutorial work plan • Outline the evaluation and marking scheme • Explaining course outcomes(Cos) • Introductory topics of the subject • Automation in industries • Manufacturing Systems and their types • Industry 4.0	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Case Study 1, Automation in Industries	CO1,CO2
6.	• Numerical Control • Computer Numerical Control • Quiz	• Case study 2, Doubt clearance • By dividing the batch in two groups, 2 case studies will be discussed	CO3,CO4
Minor Test			
7.	• NC Part Programming • Quiz	• Case Study 3, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO4,CO5
8.	• Computer Integrated Manufacturing • Robotics. • Self-Study	• Case study 4, Doubt clearance • Assignment (Discussion and presentation on self-study topics by the students and addressing the problems given in assignment) • Through discussion, Presentation or video demonstration	CO5,CO6

Practical Content

Sr. No.	Title of the experiment/case study	Performance based/ study based experiments	Unit covered
1.	3D printing of any automotive component	Performance based	3 & 4

1.	**Case study/ mini project (to be allotted during the semester)**	Case Study: Impact of Smart Manufacturing in the automotive industries	

Evaluation Scheme:

Theory Part (80 Marks) • **Major: 45 Marks (45%)** • **Minor: 25 Marks (25%)** • **Online Quiz (s): 10 Marks (10%)**
Practical Part (Total 20 marks) ☐ Assignment, Class Tests, case study presentations: **20 Marks (20%)**
Total: 100 Marks
NOTE: In order to pass this course a student must secure **30%** marks in minor+major with overall **40%** marks in total

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Product Design and Development	**3. Course Code** **Code: MEL470**	**4. L- T-P** 2-0-2	**5. Credits** 3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☑ Open Elective ☐		
7. Frequency of offering (check one): Odd ☐ Even ☐ Either semester ☑ Every semester ☐			
8. Brief Syllabus: Introduction to Product design and development. Development Processes and Organizations, Opportunity Identification, Product Planning, Identifying Customer Needs, Product Specifications, Concept-generation, selection and testing. Product life-cycle, Selection of a profitable product. Industrial design, Design for Environment, Design for manufacturing, Prototyping, robust design, Patents and Intellectual Property. Product Development Economics. Mini Projects for teams.			
9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)			
Lectures: 28	**Tutorials: ---**	**Practice: 28**	

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	To understand the process of product design and development.
CO 2	To identify the opportunity and customer needs for product design.
CO 3	To understand the various product design tools.
CO 4	To learn the process of filing patents and product commercialization.

11. UNIT WISE DETAILS **No. of Units: 5**

Unit Number: 1 No. of Lectures: 7 Title: Introduction to Product Design and Development

Introduction to product design and development, Product life-cycle, Product policy of an organization and selection of profitable products, Opportunity Identification, Product Planning, Identifying Customer Needs, Product design process, Product design steps and product analysis.

Unit Number: 2 No. of Lectures: 7 Title: Problem Identification and Analysis for Successful Product

Value engineering in product design; Advantages, Applications in product design, Problem identification and

selection Analysis of functions Anatomy of functions, Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST) and Case studies.

Unit Number: 3 No. of Lectures: 6 Title: Tools for Product Design

Introduction to product design tools, QFD, Computer Aided Design, Robust design DFX, DFM, DFA, Ergonomics in product design, Customer feedback system and case studies.

Unit Number: 4 No. of Lectures: 4 Title: Design for Manufacture and Assembly

DFMA guidelines, Product design for manual assembly, Design guidelines for metallic and non-metallic products to be manufactured by different processes such as casting, machining injection molding etc. Rapid prototyping, needs, advantages, working principle of SLA, LOM and SLS.

Unit Number: 5 No. of Lectures: 4 Title: Product Development and Intellectual Property

Product development methodologies, Lean Product Development (LPD), Design for Six Sigma (DFSS), Flexible Product Development, etc., Standardization, Product Development Economics, Patents and Intellectual Property

11. Brief Description of Self-learning component by students (through books/resource material etc.):
Product development case studies, NPTEL course (https://nptel.ac.in/courses/112107217/)

13. Contextual learning component(s)

Guest Lecture on new product development, Industrial visits, and mini projects.

14. Books Recommended:

Product Design and Development 5th Edition By Karl Ulrich, Steven Eppinger Mc Graw Hill, 2017

Handbook of New Product Development Management edited by Christoph Loch, Stylianos Kavadias, Elsevier

Product Design: Techniques in Reverse Engineering and New Product Development Kevin N. Otto, Kristin L.

Wood Prentice Hall, 2001.

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	COs covered

1.	Designing of simple product as per needs	Group discussion	1 and 2
2.	Use of product design tool to evaluate a given product.	Group discussion	3
3.	Workshop on patent filing	External expert session	4

Practical Content

Sr. No.	Title of the experiment/case study	Performance based/ study-based experiments	Unit covered
1.	Apple case study	Study based	1
2.	Customer requirements and needs: Methods to capture and interpretation	Study based	2
3.	Methods of product design	Study based	3
4.	Infringement of patents	Study based	4

1.	**Case study/ mini project (to be allotted during the semester)**	Mini projects on the basis of society needs will be distributed among group of four students	

Evaluation Scheme:

Minor: 20

Major: 40

Mini Project: 10

Online Quiz: 10

Assignments/Continuous evaluation through case studies: 20

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
Course Name: Optimization Techniques **2.**	**3. Course Code** **Code: MEL 677 IP**	**4. L- T-P** 2-0-2	**5. Credits** 3
6. Type of Course (Check one):	Programme Core ☐ Programme Elective ☐ Open Elective ☑		
7. Frequency of offering (check one): Odd ☐ Even ☐ Either semester ☑ Every semester ☐			

8. Brief Syllabus: Introduction and Basic Concepts:- Historical Development; Engineering applications of Optimization; Art of Modeling, Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems; Classification of optimization problems; Optimization techniques; Functions of single and two variables; Global Optimum; Convexity and concavity of functions of one and two variables; Optimization of function of one variable and multiple variables; Gradient vectors; Optimization of function of multiple variables subject to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation; Eigen values; Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Elementary operations; Graphical method for two variable optimization problem; Examples; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems; Revised simplex method; Duality in LP; Primal dual relations; Dual Simplex; Use of software for solving linear optimization problems using graphical and simplex methods; Examples for transportation, structural and other optimization problems; Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality; Problem formulation and application in Design of continuous beam and Optimal geometric layout of a truss; Water allocation as a sequential process; Capacity expansion and Reservoir operation; Integer linear programming; Concept of cutting plane method; Mixed integer programming; Solution algorithms; Examples; Piecewise linear approximation of a nonlinear function; Multi objective optimization – Weighted and constrained methods; Multi level optimization; Direct and indirect search methods; Evolutionary algorithms for optimization and search; Applications in Robotics

9. Total lecture, Tutorial and Practical Hours for this course (Take 14 teaching weeks per semester)

Lectures: 14	**Tutorials: ---**	**Practice: 28**

10. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed

CO 1	Understanding optimization technique and its application
CO 2	Apply LPP model to solve industrial problem
CO 3	Analyze Integer programming
CO 4	Use evolutionary algorithms for optimization and search in Robotics and automation

11. UNIT WISE DETAILS **No. of Units: 5**

Unit Number: 1 **No. of Lectures: 4**

Content Summary: Introduction and Basic Concepts:- Historical Development; Engineering applications of Optimization; Art of Modeling, Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems; Classification of optimization problems; Optimization techniques; Functions of single and two variables; Global Optimum;

Unit Number: 2 **No. of Lectures: 7**

Content Summary: Convexity and concavity of functions of one and two variables; Optimization of function of one variable and multiple variables; Gradient vectors; Optimization of function of multiple variables subject to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation; Eigen values; Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models;

Unit Number: 3 **No. of Lectures: 6**

Content Summary: Elementary operations; Graphical method for two variable optimization problem; Examples; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems; Revised simplex method; Duality in LP; Primal dual relations;

Unit Number: 4 **No. of Lectures: 4**

Content Summary: Use of software for solving linear optimization problems using graphical and simplex methods; Examples for transportation, structural and other optimization problems; Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality; Problem formulation and application in Design of continuous beam and Optimal geometric layout of a truss; Water allocation as a sequential process; Capacity expansion and Reservoir operation; Integer

linear programming;

Unit Number: 5 **No. of Lectures: 4**

Content Summary: Optimal geometric layout of a truss; Water allocation as a sequential process; Capacity expansion and Reservoir operation; Integer linear programming; Concept of cutting plane method; Mixed integer programming; Solution algorithms; Examples; Piecewise linear approximation of a nonlinear function; Multi objective optimization – Weighted and constrained methods; Multi level optimization; Direct and indirect search methods; Evolutionary algorithms for optimization and search;

12. Brief Description of Self-learning component by students (through books/resource material etc.):

Nptel/Mooc/Online

13. Contextual learning component(s)

Case studies on various optimization theories

14. Books Recommended:

1. An introduction to Optimization by Edwin P K Chong, Stainslaw Zak

2. Nonlinear Programming by Dimitri Bertsekas

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	COs covered
1.	• Outline the tutorial objectives and tutorial work plan • Outline the evaluation and marking scheme • Explaining course outcomes(Cos) • Introductory topics of the subject • Numerical Problems on various topics of optimization	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Tutorial Sheet 1, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	All COs

Practical Content

Sr. No.	Title of the experiment/case study	Performance based/ study based experiments	Unit covered
1.	Matrix operations in Matlab	Analytical/Software based Study	1
2.	Differentiation of a vector and matrix in Matlab	Analytical/Software based Study	2
3.	Integration of a vector and matrix in Matlab	Analytical/Software based Study	3
4.	Simplex algorithm in Matlab	Analytical/Software based Study	4
5.	Implementation of Lagrange multiplier method in Matlab	Analytical/Software based Study	5

1.	**Case study/ mini project (to be allotted during the semester)**	To be done individually or in groups, Discussion and presentation by the students and addressing the problems given in assigned study	

Evaluation Scheme:

Theory Part (100 Marks) □ Major: **45 Marks** □ Minor: **25Marks** □ Online Quiz (s): **10 Marks** □ Assignment, Class Tests, presentations, projects: **20 Marks**
Total 100 Marks **Note:** in order to pass this course a student must secure 30% marks in minor + major with overall 40% marks in total