Syllabus and Course Outcomes

B.Tech in Mechanical Engineering

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Engineering Graphics and Drawing	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEP110	1-0-4	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: Types and use of lines and lettering; dimensioning; first and third angle systems of orthographic projection; projection of points in different quadrants; projection of lines; projection of planes; projections of solids; development of surfaces; section of solids (section planes, sectional views, true shape of sections); isometric projections.

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

Lectures: 14 hours	**Tutorials: ---**	**Practice: 56 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	Use standard font and lines in engineering drawings
CO 2	Draw orthographic views of basic planar and solid objects
CO 3	Develop basic 3-D surfaces.
CO 4	Draw the sections of simple solid objects cut by a plane
CO 5	Draw isometric views of basic solid objects

11. UNIT WISE DETAILS No. of Units: ___7_____

Unit Number: 1 No. of Lectures: 8 Title: Introduction to engineering drawing

Importance and application of engineering drawing; Types of line; Lettering; Dimensioning; Orthographic projection; Projection of points

Unit Number: 2 No. of Lectures: 6 Title: projection of lines

Content Summary: Projection of straight lines inclined to one reference plane and both the planes

Unit Number: 3 No. of Lectures: 8 Title: projection of planes

Content Summary: Projection of planar shapes inclined to one reference plane and both the planes

Unit Number: 4 No. of Lectures: 8 Title: projection of solids

Content Summary: Projections of prisms, cylinders, cones, and pyramids with axis inclined to one and both reference planes

Unit Number: 5 No. of Lectures: 10 Title: development of surfaces

Content Summary: Parallel-line development; Radial-line development; Triangulation development; Approximate method

Unit Number: 6 No. of Lectures: 10 Title: sections of solids

Content Summary: Sketching the shape of the cut surfaces of simple solids: prisms, pyramids, cylinders and cones

Unit Number: 7 No. of Lectures: 8 Title: Isometric view

Content Summary: Isometric Scale and True Scale; Isometric view and isometric projection; Isometric view of simple planar figures such as square, circle, polygons; Isometric view of solid objects; isometric view and isometric projection of spheres

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

Projection of some solid objects to be studied by students

13. Books Recommended :

Text Books:

1) Bhatt, N. D., “Engineering Drawing”, 53rd ed., Charotar Publication, 2014.

2) Jhole, D. A., “Engineering Drawing”, 2nd ed., Tata McGraw-Hill, 2008.

Reference Books:

Gill, P. S., “Engineering Drawing”, 12th Edition, S K Kataria & Sons, 2013.

Reference websites:

http://nptel.ac.in/courses/112103019/

The practice part will have following components

Sr. No.	Topic	Cos covered
1.	Letter writing and types of lines (4 hours)	1
2.	Projection of Points (4 hours)	1
3.	Projection of Lines (6 hours)	2
4.	Projection of planes (8 hours)	3
5.	Projection of Solids (8 hours)	4
6.	Development of Surfaces (10 hours)	5
7.	Sections of solids (10 hours)	6
8.	Isometric views (8 hours)	7

COURSE TEMPLATE

1. Department:	**Mechanical Engineering**		
2. Course Name: Basics of Mechanical and Civil Engineering	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL150	2-0-2	3 Credits
6. Type of Course (Check one):	Programme Core ✓	Programme Elective ☐	Open Elective ☐
7. Frequency of offering Odd ☐	Even ☐	Either semester ☐	Every semester ✓

8. Brief Syllabus: Introduction to Thermodynamics: Thermodynamics Laws and applications; Concepts of state, work and heat, internal energy, enthalpy and entropy. Boilers: construction, classification and application. I.C engines: two-stroke and four-stroke petrol and diesel engines; MPFI technology. Advances in automobile technologies. Simple lifting Machine. Power Transmission. Stress and strain. Applied Mechanics: Force System, Laws of Mechanics and Introduction of Moment of Inertia. Engineering materials: classification, properties & applications. Introduction to Conventional and Unconventional Manufacturing processes; Plant layout. Introduction to Mechatronics and Robotics. Introduction to Engineering Surveying and Smart Infrastructure.

Tutorials: Numericals based on thermodynamics, stress-staring, applied mechanics, lifting machines, and Surveying.

Practicals: Experiments of lifting machines. Study of engine and boiler models. Making jobs in welding shop, Machining Shop, Foundry Shop and Carpentry Shop. Field Exercises of surveying.

9. Total lecture, Tutorial and Practical Hours for this course

Lectures: 30 hours	**Practical/Tutorials: 30 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	Basic understanding thermodynamics and its applications
CO 2	Understand the basics of Engineering Materials (its applications) and Stress-Strain
CO 3	Basic understanding of boilers, engines and latest automobile technologies.
CO 4	Understand the basics Applied Mechanics, Simple lifting Machines & Power Transmission

CO 5	Understand basics of Manufacturing
CO 6	Understand the basics of Robotics and Mechatronics
CO7	Understand the basics of Engineering surveying and Smart Infrastructure Development.

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

Unit Number: 1 Hours for lectures: 5 Title: Introduction to Thermodynamics

Content Summary

Concepts of state, thermodynamic properties, work, heat transfer, internal energy, enthalpy, entropy, State, Path, Cycle and Process. Types of systems. Thermodynamics Equilibrium. Quasi-static Equilibrium. Work done for Quasi-static Equilibrium processes. Laws of thermodynamics. First law for closed and open system. Heat engine, heat pump & refrigerator.

NOTE: There will be one tut-sheet for this unit

Outcomes Covered: CO 1

Unit Number: 2 Hours for lectures: 3 Title: Engineering Materials and Stress-Strain

Content Summary:

Introduction, concept and types of stresses and strains. Poison's ratio. Hooks Law. Elastic constants. Introductory classification of engineering materials. Smart materials. Classification of properties of materials and their definition.

NOTE: There will be one tut-sheet for this unit

Outcomes Covered: CO 2

Unit Number: 3 Hours for lectures: 4 Title: Introduction to Boilers, IC Engines and automobile technologies

Content Summary

Introduction. Classification of boilers. Applications, Constructional and operational details of Cochran and Babcock & Wilcox boilers with their detailed diagrams. Mountings and Accessories. Introduction and

classification of I.C engines. Two-stroke and four-stroke petrol and diesel engines. Brief of MPFI technology. Advances in automobile technologies.

Outcomes Covered: CO 3

Unit Number: 4 Hours for lectures: 5 Title: Applied Mechanics, Simple lifting Machines & Power Transmission

Content Summary

Applied Mechanics: Force System (incl. Parallelogram Law of Forces, Lami's Theorem, Resultant of Forces). Laws of Mechanics. Introduction of Moment of Inertia.

Simple lifting Machines: Definition of Simple and compound lifting machines. Velocity ratio. Mechanical advantage. Load, effort and efficiency. Law of machines. Reversibility of machine. Simple and Differential Wheel & axle. Single purchase and double purchase winch crab.

Power Transmission: Belt, chain and gear drives. Types of Gears.

NOTE: There will be one tut-sheet for this unit

Outcomes Covered: CO 4

Unit Number: 5 Hours for lectures: 6 Title: Introduction to Production Engineering

Content Summary

Introduction. Types of production systems. Introduction to manufacturing processes. Plant layouts. Casting and foundry. Pattern allowance. Types of Metal working. Hot and cold metal working. Rolling. Extrusion. Introduction to machining. Lathe (operations performed on lathe machine), Planner, Shaper, Drilling, Milling and Grinding. Introduction to Abrasive jet machining, Ultrasonic Machining and Electrical discharge Machining. Flexible manufacturing Systems. Gas, Arc and Resistance welding. Differences between welding, brazing, soldering and braze welding.

Outcomes Covered: CO 5

Unit Number: 6 Hours for lectures: 3 Title: Intro. to Robotics and Mechatronics

Content Summary

Concept of integration of Mechanical, Electrical and Computer Technologies. Introduction to Robotics: Components and classification. Applications of Mechatronics and Robotics.

Outcomes Covered: CO 6

Unit Number: 7 Hours for lectures: 4 Title: Introduction to Engineering Surveying & Smart Infrastructure Development

Content Summary

Calculation of reduced level. Height of instrument and rise and fall method. Correction for curvature and refraction. Differential leveling. Reciprocal Leveling. Contours and methods of contouring. Introduction to Smart Infrastructure-Buildings & Transportation Systems

NOTE: There will be one tut-sheet for this unit

Outcomes Covered: CO 7

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

1. Factories Act, Safety regulations Product safety
2. Role of management and role of Govt. in industrial safety

13. Contextual learning component(s)

- Hands-on experience of using Mechanical Measurement instruments.
- Hands-on experience of material processing like Metal Machining, Sheet metal, Carpentry, Arc & Gas Welding, and Foundry.
- Industrial Visit to Automobile Industry
- On field exercises of surveying.

14. Books Recommended :

(a) Text Books:

1. Jain Vineet, "Basics of Mechanical Engineering", 2nd Edition, Dhanpat Rai Publications, 2016
2. Singh D.K., "Elements of Mechanical Engineering", 1st Edition, Ane Books Pvt. Ltd., 2012
3. Kumar Parvin, "Basic Mechanical Engineering", 1st Edition, Pearson Education India, 2013
4. Gokak G.D., Kittur J K., "Elements of Mechanical Engineering", Wiley, 2014
5. Manglik V. K., "Elements of Mechanical Engineering", PHI, 2013
6. Elements of Mechanical Engineering by R. K. Rajput, Laxmi Publications (P) Ltd., New Delhi
7. Elements of Mechanical Engineering by Dr. D. S. Kumar,S. K. Kataria & Sons, New Delhi.
8. Engineering Thermodynamics by P. K. Nag, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
9. Workshop Technology by S. K. Garg, Laxmi Publications (P) Ltd., New Delhi.
10. S.K. Duggal, Surveying (Vol. 1), TataMcGraw Hill
11. J.L Meriam & L.G. Kraige, Engineering Mechanics, John Wiley & Sons

(b) Reference Books:

1. Rizza Robert, "Introduction to Mechanical Engineering", Person, 2001
2. Workshop Technology by Hajara & Chaudhary.
3. A Handbook for Mechanical Engineering, 2nd Edition, Made Easy Publications, 2015
4. S.S. Bhavikatti, Surveying & Levelling (Vol. 1), IK International Publishing House.
5. S. S. Bhavikatti, K. G. Rajashekarappa, Engineering Mechanics, New Age International Ltd.
6. Sussman Joseph, Perspectives on Intelligent Transportation Systems (ITS), New York, NY: Springer.

(c) Online Resources:

1. http://www.youtube.com/watch?v=1cFu2bkZ7Vw&feature=related (IC engine)
2. http://www.youtube.com/watch?v=pCg1Ih_oVSA (pump)

3. http://www.youtube.com/watch?v=V3aPHmZ97yM&feature=related (pump)
4. http://www.youtube.com/watch?v=FENCiA-EfaA&feature=related (impeller)
5. http://www.youtube.com/watch?v=TBdUcGYo7XA (gas turbine)
6. http://www.youtube.com/watch?v=HzQPNpP55xQ (turbines)
7. http://www.youtube.com/watch?v=e_CcrgKLyzc (coal power plant)
8. http://www.youtube.com/watch?v=8GSUgwombdE&feature=related (boiler)
9. http://www.youtube.com/watch?v=A3ormYVZMXE (hy.lift)
10. http://www.youtube.com/watch?v=FP05rYRI9JU&feature=related (hy.pump)
11. http://homepages.cae.wisc.edu l: http://www.youtube.com/watch?v=E6_jw841vKE&feature=related (air compressor)
12. http://www.youtube.com/watch?v=twM-GLUYQ-o&feature=related (belt drive)
13. http://www.youtube.com/watch?feature=endscreen&v=gjUwJ1CJVq4&NR=1 (belt drive)
14. http://www.youtube.com/watch?v=XunM7yUC06M&feature=related (gear drive)
15. http://www.youtube.com/watch?v=ftdgB93QOD8&feature=related (gear box)
16. http://en.wikipedia.org/wiki/Boiler
17. https://www.youtube.com/watch?v=t7zvl6wCemg (Leveling)
18. https://nptel.ac.in/courses/105107122/13 (Leveling)
19. https://nptel.ac.in/courses/122104015/ (Engineering Mechanics)
20. https://nptel.ac.in/courses/105101008/48 (ITS)

15. Practical Content

Sr. No.	Title of the Experiment	Hours
1	To Study the Cochran and Babcock & Wilcox Boilers and Working and the Function of Mountings and Accessories in Boilers	2
2	To Study Two Stroke & Four Stroke Petrol and Diesel Engines.	2
3	To Calculate the V.R., M.A., And Efficiency of Single purchase winch crab and differential wheel and axle.	2
4	Machine Shop: Study of machines in Machine Shop and Job making in that shop	2
5	Welding Shop: To prepare welded joints suitable for lap welding and butt welding and Perform the following welding process (a) Soldering (b) Brazing (c) Braze welding (d) Gas welding	2
6	Sheet Metal and fitting Shop: To study different types of fitting and sheet metal tools and marking tools used in fitting and sheet metal shop	2
7	Foundry Shop: To prepare mould and core assembly, pour molten metal and fettle the casting.	2
8	Carpentry Shop: Study of carpentry hand tools for their construction and use and to make a T Lap Joint	2

9	Measurement of reduced level by using total station and auto-level	4
10	Tutorials, online quiz, Assignments, Evaluation etc	10

16. Evaluation Scheme :

Theory Part (130 Marks)

- Major: 70 Marks (35%)
- Minor: 30 Marks (15%)
- Assignment, Class Tests, presentations, project etc: 20 Marks (10%)
- Online Quiz (s): 10 Marks (5%)

Practical Part (Total 70 marks)

Continuous Evaluation (50 Marks)	**End semester exam (20 Marks)**
Each experiment shall be evaluated for 10 marks and at the end of the semester proportional marks shall be awarded out of 50. Following is the **breakup of 10 marks** for each experiment: • **4 marks:** Observation & conduct of experiment. Teacher may ask one or two questions while checking observations • **3 marks :** For report writing • **3 marks:** For the 15 minutes quiz to be conducted in every lab.	End semester practical evaluation including **Mini project (if any)** carries 20 marks.

Total : 200 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: Mechanics of Solids-1	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL203	3- 0-2	4
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: Concept of stress and strain, Hooke's law, Principal of superposition, One and two-dimensional stress problems, Thermal stresses and strains, Complex stresses and strains, Principal stresses, 2D & 3D Mohr's circle of stress and strain. Shear force and bending moment diagrams for beams. Bending and shearing stresses in beams, Deflection of beams. Torsion of circular sections and thin walled tubes. Concept of strain energy, Strain energy due to axial loading, pure shear, bending, and twisting. Stresses due to gradually applied load, suddenly applied load, impact or shock load.

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

Lectures: 42 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 evaluate the value of stress, strain and deformation subjected to different loading conditions.
CO 2	To compute the value of stresses at any oblique plane at a point in a stressed member. Also, to locate the Principal planes, plane of maximum shear and draw Mohr's Circle.
CO 3	To draw the shear force and bending moment diagram to analyse bending stress, shear stress and deflection of symmetrical beams subjected to transverse loading conditions.
CO 4	To analyse the torsional shear stress acting on circular shafts subjected to twisting couple.
CO 5	To compute the strain energy in a machine member under different loading conditions.

11. UNIT WISE DETAILS No. of Units: 6

Unit Number: 1 No. of Lectures: 14 Title: Concept of Stress and Strain

Content Summary: Concept of stress and strain, Hook's law, Principal of superposition, One and two dimensional stresses problems, Thermal stresses and strains, Complex stresses and strains, Principal stresses, 2D & 3D

Mohr's circle of stress and strains

Unit Number: 2 No. of Lectures: 7 Title: Bending and Shearing Force in Beams

Content Summary: Shear force and bending moment diagrams for different loading conditions on different types of beams

Unit Number: 3 No. of Lectures: 7 Title: Bending & Shear Stress in Symmetrical Beams

Content Summary: Pure Bending, Bending Equation, and Bending Stress in different Beams of Symmetrical sections, Shear stress in symmetrical section beam

Unit Number: 4 No. of Lectures: 6 Title: Deflection of Beams

Content Summary: Deflection Equation, Deflection in different beams under different loading conditions

Unit Number: 5 No. of Lectures: 7 Title: Torsion

Content Summary: Pure Torsion, Torsion Equation, Torsion of Circular Sections and Thin Walled Tubes

Unit Number: 6 No. of Lectures: 4 Title: Strain Energy

Content Summary: Concept of strain energy, Strain energy due to axial loading, pure shear, bending, and twisting, Stresses due to gradually applied load, suddenly applied load, impact or shock load

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

The students should study the text-books, reference books and digital study material to get in-depth knowledge of the subject and practice the numerical as much as they can. Students need to prepare for Mohr's Circle of Strain on their own.

13.Books Recommended:

(b). Text Books:

- Ratan, S.S., "Strength of Materials", 3rd edition, McGraw Hill Education, 2016

(c). Reference Books:

- Gere, J.M., Goodno, B.J., "Mechanics of Materials", 8th edition, Cengage Learning, 2013
- Rajput, R.K., "Strength of Materials", 6th edition, S.Chand Publishing, 2015

(d). Reference Website:

- http://nptel.ac.in/courses/105102090/
- http://nptel.ac.in/courses/105106116/
- https://www.coursera.org/learn/mechanics-1
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-050-solid-mechanics-fall-2004/
- http://nptel.ac.in/courses/112101095/

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	Cos covered
1.	• Concept of stress and strain, Hook's law, Principal of superposition, One and two dimensional stresses problems, Thermal stresses and strains, Complex stresses and strains, Principal stresses, 2D & 3D Mohr's circle of stress and strains	• Explanation of basics of Stress and Strain with the help of video/animated lectures and real life examples • Tutorial Sheet 1 and 2 • Practice & Doubt clearance sessions	CO1, CO2
2.	• Shear force and bending moment diagrams for different loading conditions on different types of beams	• Explanation of Shear Force and Bending moment diagrams with the real-life examples • Tutorial Sheet 3 • Practice & Doubt clearance sessions	CO3
3.	• Pure Bending, Bending Equation, and Bending Stress in different Beams of Symmetrical sections, Shear stress in symmetrical section beam	• Explanation of the concept of Pure Bending and application of Bending equations with the help of video/animated lectures and real life examples • Tutorial Sheet 3 • Practice & Doubt clearance sessions • Surprise quiz covering sr. no. 1,2,3	CO 3
Minor Test			
4.	• Deflection Equation, Deflection in different beams under different loading conditions	• Deriving Deflection Equation and explain its application under different loading conditions with the help of video/animated lectures and real life examples • Tutorial Sheet 4 • Practice & Doubt clearance sessions	CO3
5.	• Pure Torsion, Torsion Equation, Torsion of Circular Sections and Thin Walled Tubes	• Explanation of the concept of Pure Torsion and application of Torsion equations with the help of video/animated lectures and real life examples • Tutorial Sheet 4 • Practice & Doubt clearance sessions	CO 5
6.	• Concept of strain energy, Strain energy due to axial loading, pure shear, bending, and twisting, Stresses due to gradually applied load, suddenly applied load, impact or shock load	• Explanation of the Concept of strain energy, Strain energy due to axial loading, pure shear, bending, and twisting, Stresses due to gradually applied load, suddenly applied load, impact or shock load with the help	CO 6

		of video/animated lectures and real life examples • Tutorial Sheet 3 • Practice & Doubt clearance sessions • Surprise quiz covering sr. no. 4,5,6	

Practical Content

Sr. No.	Title of the Experiment	Software/Kit based/Component based	Unit covered	Time Required
1.	To perform the tensile test on UTM	**Machine Based**	**1**	**90 min**
2.	To perform the compression test on UTM	**Machine Based**	**1**	**90 min**
3.	To perform the shearing test on UTM	**Machine Based**	**2**	**90 min**
4.	To perform the bending test on UTM	**Machine Based**	**3**	**90 min**
5.	To perform the torsional test	**Machine Based**	**5**	**90 min**
6.	To perform the Brinell and Rockwell hardness test	**Machine Based**	**1**	**90 min**
7.	To perform the toughness test	**Machine Based**	**6**	**90 min**
8.	To perform the fatigue test	**Machine Based**	**1**	**90 min**
9.	To perform the cupping test	**Machine Based**	**1**	**90 min**

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

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Thermodynamics	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL 290	3-1-0	4
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:

Basic Concepts: Introduction to Basic concepts, work and heat. Laws: Zeroth Law, 1st law of thermodynamics for closed and open systems, concept of internal energy and enthalpy, 2nd law of thermodynamics-corollaries, Clausius inequality, entropy, statement of 3rd law of thermodynamics. Availability Concepts: Availability, irreversibility and Application of 2nd Law Efficiency. Pure substances. Mixtures of Ideal and Real gas. Properties of steam. Joule-Kelvin Effect. Clausius-Clapeyron Equation.

Practice(P): Experiments based on application of 1st and 2nd law of thermodynamics for various systems will be conducted. Tutorials/Problem solving exercises based on theory will be conducted. Quizzes will also be conducted during practice sessions. Case studies and Lab project will be covered.

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

Lectures: 42 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	Demonstrate a basic understanding of the nature of thermodynamic processes, its laws and application to systems.
CO 2	Develop understanding how thermodynamic relations are used in evaluation of thermodynamic properties and to identify & formulate thermodynamic problem.
CO 3	Understand the construction of thermodynamic property tables and the capability to determine changes in enthalpy, entropy and internal energy.
CO 4	Apply basic laws of thermodynamics in analysis and design of thermodynamic cycles including vapor and gas power cycles, refrigeration cycles, and heat-pump.

CO 5	Learn the concept of exergy (energy availability) and exergy analysis of thermodynamic systems.
CO 6	Study thermodynamic properties of pure substances & ideal gas mixtures.

11. UNIT WISE DETAILS No. of Units: ___5_____

Unit Number: 1 No. of Lectures: 8 Title: Basic Concepts

Content Summary: Macroscopic & microscopic approaches, Thermodynamic System, Surrounding & Boundary, Thermodynamic properties, equilibrium, State, Path, Process & cycle, Quasi static, Reversible & irreversible processes, Thermodynamic work & heat transfer, Zeroth Law.

Unit Number: 2 No. of Lectures: 7 Title: First Law of Thermodynamics

Content Summary: Energy, Internal Energy, Enthalpy, Steady flow energy equation & applications, 1^{st} law for non-flow processes, Limitations of 1^{st} law.

Unit Number: 3 No. of Lectures: 13 Title: Second Law of Thermodynamics

Content Summary: Heat source & sink, heat engine, Refrigerator & heat pump, Kelvin Planck &Clausius statements, Carnot cycle in heat engine, Entropy, Clausius inequality, Entropy of universe increasing, Zero temperature in thermodynamic temperature scale, Introduction to third law**.**

Unit Number: 4 No. of Lectures: 6 Title: Availability & Irreversibility

Content Summary: High & Low grade energy, Available & unavailable energy, Useful work, dead state, Availability for non-flow & steady flow systems, Second law efficiency.

Unit Number: 5 No. of Lectures: 8 Title: Properties of Pure Substances & Gas Mixtures, Thermodynamic Relations

Content Summary: Phase transformations, Evaporation & boiling, Saturated & superheated steam, T-V & P-T Plots during steam formation, Properties of dry, wet & superheated steam, Property changes during steam processes, T-S plot & H-s plot, Mixture of ideal & real gas, Maxwell Relations**.** Joule-Kelvin Effect. Clausius-Clapeyron Equation. Mixture of ideal & real gas, Maxwell Relations**.** Joule-Kelvin Effect. Clausius-Clapeyron Equation.

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

Throttling process, H-S diagram for Steam boiling, sublimation process and sources of irreversibility. Lab project and related software tools.

12. Books Recommended :
Text Books:

1) Moran M.J., Shapiro, H.N., “Fundamentals of Engineering Thermodynamics”, 7th edition or above, John Wiley & Sons, 2011 or above.
2) Borgnakke, C., Sonnta, R.E., “Fundamentals of Thermodynamics”, 7th edition or above, John Wiley & Sons, 2009 or above.

3) Cengel, Y.A., Boles, M.A., "Thermodynamics - An Engineering Approach", 7th edition or above, Tata McGraw-Hill, 2001 or above.

Reference Book:

Nag, P.K., "Engineering Thermodynamics", 5th edition or above, Tata McGraw-Hill, 2013 or above.

Reference websites:

http://nptel.ac.in/courses/112104113/

http://www.steamtablesonline.com/steam97web.aspx

https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/video-lectures/

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	Cos covered
1.	• Numerical problems based on the calculations of work and heat interaction in various quasi static processes. Numerical problems based on 1st law of thermodynamics for non-flow /closed system processes.	• 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 CO2 CO3
2.	• Numerical problems based on application of SFEE to mechanical systems. Numerical based on 2nd law of thermodynamics for heat engine, refrigeration and heat pump. • Quiz	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in 6 groups groups, oral quiz will be conducted	CO1 CO2 CO3 CO4
Minor Test			
3.	• Numerical based on entropy principle and calculation of entropy change for system. • Quiz	• Tutorial Sheet 3, Doubt clearance • By dividing the batch in six groups, oral quiz will be conducted.	CO1 CO2 CO4

4.	• Numerical based on pure substances and calculation of properties of steams using steam tables • 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	CO6

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Engineering Mechanics	**3. Course Code**	**4. L-T- P**	**5. Credits**
	Code: MEL 205	3-1-0	4
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: idealization of mechanics, force system, moment of force system, laws of mechanics. Equilibrium: free body diagrams, equilibrium equations. Structures: Simple trusses, frames and analysis of structures. Moment of inertia: types, principal axes theorem, parallel axes theorem, product of inertia, Principle of virtual work, methods of minimum potential energy, stability. Kinematics of particles and rigid bodies in plane motion, Kinetics of particles and rigid bodies: Particle dynamics, Newton's laws for plane motion, D 'Alembert's principle (Dynamic equilibrium), Impulse and momentum, Work energy equations, Impact, Collision of particles.

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

Lectures: 42 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	To work with basic engineering mechanics concepts required for analyzing static structures and to solve problems dealing with forces in an equivalent force systems.
CO 2	To model the problems using free-body diagrams and equilibrium equations and to identify and model various types of loading and support conditions that act on structural systems.
CO 3	To determine moments of inertia and centroid of different types of areas.
CO 4	To apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems

11. UNIT WISE DETAILS **No. of Units: _____6____**

Unit Number: 1 No. of Lectures: 7 Title: Introduction to Mechanics

Content Summary: Introduction to Mechanics, Idealizations of mechanics, Concepts and classification of force system, Laws of mechanics, Moment of force system, Couple, and Couple Moment. [CO1]

Unit Number: 2 No. of Lectures: 6 Title: Equilibrium

Content Summary: Introduction to equilibrium, Types of equilibrium, Resultant of system of coplanar forces, free body diagram, General equations of equilibrium, Structures: simple trusses and frames, and analysis of structures. [CO1, CO2]

Unit Number: 3 No. of Lectures: 8 Title: Moment of Inertia

Content Summary: Moment of inertia: Concept, types, Polar moment of inertia, Radius of gyration, Theorem's of moment of inertia: Parallel axis theorem (Transfer axis theorem), Perpendicular axis theorem, Moment of inertia of simple areas, Product of inertia, Principal moments of inertia. [CO3]

Unit Number: 4 No. of Lectures: 5 Title: Virtual Work

Content Summary: Introduction, Work of a force, Principle of virtual work, Applications of principle of virtual work, Methods of minimum potential energy, Stability. [CO1, CO4]

Unit Number: 5 No. of Lectures: 7 Title: Kinematics of Particles and Rigid Bodies

Content Summary: Rectilinear motion of a particle: Equations of motion, Sign convention, Motion curves, Curvilinear motion of a particle: Projectile motion, Relative motion, Kinematics of rigid bodies. [CO4]

Unit Number: 6 No. of Lectures: 9 Title: Kinetics of Particles and Rigid Bodies

Content Summary: Introduction, Particle Dynamics, Newton's law for rectangular coordinates & cylindrical coordinates, D 'Alembert's principle (Dynamic equilibrium), Work energy equations, Impulse momentum principle, Linear and Angular momentum, Impact, Collision of particles, Coefficient of Restitution. [CO4]

12. Brief Description of Self-learning component by students (through books/resource material etc.):
Frames and analysis of structures; Applications of principle of virtual work; Impact; Collision of particles; Coefficient of Restitution.

13. Books Recommended :
Text Books:

1. Dubey, N.H., "Engineering Mechanics: Statics and Dynamics", McGraw-Hill Education, 2012
2. Chandramouli, P.N., "Engineering Mechanics", PHI Learning, 2011

Reference Books:

1. I.S. Gujral, "Engineering Mechanics", Laxmi Publications, 2nd edition, 2016
2. Jindal, U.C., "A Text Book on Engineering Mechanics", Made Easy Publications, 2013

Reference websites:

http://nptel.ac.in/courses/112103109/1

The practice part will have following components

Practice No.	Practical/Tutorial/Activity	Description of Practice	Unit/CO Covered
1	Tutorial	Numerical on resultant of force system	1/CO1
2	Tutorial	Numerical on equilibrium	2/CO1,CO2
3	Case Study	Case studies on identification of force system	1/CO1
4	Tutorial	Numerical on trusses, frames, and structures	2/CO2
5	Tutorial	Numerical on MOI, centroids	3/CO3
6	Presentations	Group presentations on given topics	1
7	Tutorial	Numerical on virtual work	4/CO3
8	Tutorial	Numerical on kinematics of particles	5/CO4
9	Tutorial	Numerical on kinematics of rigid body	5/CO4
10	Tutorial	Numerical on kinetics of particles	6/CO4
11	Case Study	Case study on kinematics of rigid body	5/CO4
12	Tutorial	Numerical on kinetics of rigid body	6/CO4
13	Presentations	Presentations of mini-project	1, 2
14	Presentations	Presentations of mini-project	1, 2
Details of Mini Project: Mini-projects on design and evaluation of force system equilibrium using FEA analysis.			

COURSE TEMPLATE

1. Department /School : Mechanical Engineering			
2. Course Name	**3. Course Code**	**4. L-T-P**	**5. Credits**
Energy Conversion	MEL 314	3-0-2	4

6. Type of Course (Check one): Programme Core ☑ Programme Elective ☐ Open Elective ☐

7. Pre-requisite(s), if any	Thermodynamics
(Mention course code and name)	MEL290

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

9. Brief Syllabus

Energy sources, Combustion equations, Stoichiometric air fuel ratio, calorimeters, Determination of calorific value of fuels; Introduction to Thermal Power Plant; Gas power cycles, Vapour power cycles (Rankine cycle, Reheat & Regeneration), Binary Vapour cycles, Cogeneration; Boilers: mountings and accessories, Low pressure and High pressure boilers; Nozzles, Classification of steam turbines, Compounding of Impulse Turbine, Condensers, Air Compressors.

Practice(T/P): Numerical on energy conversion and lab work by students

10. Total Lecture, Practice (Tutorial and Practical) Hours for this course (Take 14 teaching weeks per semester)

Lectures: 42 Practice (T/P): 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	Select & apply appropriate methods & principles of thermodynamics and combustion to model & analyze engineering situations
CO 2	Demonstrate the use and application of various components of a steam power plant
CO 3	Demonstrate the technical requirements of energy conversion devices
CO 4	Estimate heat balance, work & efficiency of thermal systems/cycles

12. UNIT WISE DETAILS **No. of units : __5_**

Unit Number: 1	**Title:** Fuel and Combustion	**Lectures: 4**
Content Summary: Introduction, Types of Fuel, Proximate Analysis and ultimate Analysis of Fuel, Calorific Value of Fuel, Chemistry of Combustion, Calorimeters		
Outcomes Covered: CO1, CO2		

Unit Number: 2	**Title:** Thermal Power Plant	**Lectures: 6**
Content Summary: Introduction, Rankine Cycle, Topping and Bottoming Cycles, Steam Boilers, Mountings and		

Accessories, Working of Steam Power Plant, Cycle Components, Cycles with Modern Steam Power Plant	
Outcomes Covered: CO1, CO2,CO4	
Unit Number: 3	**Title:** Gas Power Cycles: **Lectures: 4**
Content Summary: Otto Cycle, Diesel cycle, Dual cycle, Stirling cycle, Erricson and Brayton Cycle and their efficiency calculations.	
Outcomes Covered: CO3, CO4	
Unit Number: 4	**Title:** Steam & Gas Turbines **Lectures:8**
Content Summary: Steam Turbines, Compounding of Turbines, Velocity Triangles, Fuels and Firing, Efficiency, Gas Turbine Cycle, Cycle Configurations, Components Used in Complex Cycles, Modern cycles.	
Outcomes Covered: CO3	
Unit Number: 5	**Title:** Condensers and Compressors **Lectures: 6**
Content Summary: Condensers: Introduction, Classification, Air leakage, compressors, Multi Stage Compression, Intercooler, Calculation of Pressure ratio and efficiency with or without Considering Clearance Volume	
Outcomes Covered: CO3, CO4	
13. Title of Lab. **manual, if applicable:**	**Energy Conversion**

14

(a). Text Books:

1) Thermal Engineering by R.K.Rajput, Laxmi Publications

2) Thermal Engineering by P.L. Ballaney, Khanna Publishers

(b). Reference Books:

1) Steam and Gas Turbines by A. Kostyuk, V. Frolov, Mir Publishers

2) Combined-Cycle Gas & Steam Turbine Power Plants by Rolf Kehlhofer, Pennwell Publisher

(c). Reference Website:

http://nptel.ac.in/courses/105108075/module9/

15. Contextual Learning Component(s) Visit of nearby power plant may be scheduled, videos of working of power plants, turbines.

16. Details of Practice (Practical/Tutorial/Activity)

Practice No.	Practical/Tutorial/Activity	Description of Practice	Unit Covered

1	Practical	To study boilers, their mountings and accessories	
2	Practical	To study the working of impulse and reaction turbines	
3	Practical	To find power output and efficiency of a steam turbine	
4	Practical	To find calorific value of a sample of fuel using bomb calorimeter	
5	Practical	To find volumetric efficiency of a reciprocating compressor	
6	Tutorial	Numerical problems –Fuels and combustion	
7	Tutorial	Numerical problems – Rankine cycles (Boilers)	
8	Tutorial	Numerical problems – Rankine cycles	
9	Tutorial	Numerical problems – gas power cycles	
10	Tutorial	Numerical problems – gas power cycles	
11	Tutorial	Numerical problems - Nozzles	
12	Tutorial	Numerical problems - steam turbines	
13	Tutorial	Numerical problems – steam turbines	
14	Tutorial	Numerical problems - compressors	
Details of Mini Project: case study type mini projects/workshop based on some of the concepts studied during the course.			

Evaluation scheme

Theory Part (130 Marks) □ Major: 70 Marks □ Minor: 30 Marks □ Test/Online Quiz (s)/:30 Marks
Practical Part (**Total 70 marks**) □ Experiments/tutorial assignments: 50 Marks □ Final practical/viva: 20 Marks
Total 100 Marks ***NOTE:*** IN ORDER TO PASS THIS COURSE A STUDENT MUST SECURE 30% MARKS IN MINOR+MAJOR WITHOVERALL 40% MARKS IN TOTAL

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Machine Drawing	**3. Course Code**	**4. L-T- P**	**5. Credits**
	Code: MEP107	0-0-4	2
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: Sectional views: full and half section views, standard practices; Tolerance: coordinate tolerancing, geometric tolerancing, gauging and measuring principles, material conditions, tolerance symbols; Assembly drawing: types of assembly drawing, sectioning, dimensioning, and hidden lines in assembled views, standard parts in assembled views; Computerized 2-D drawing using AutoCAD: draw toolbar; modify toolbar; dimensioning toolbar; properties toolbar; ortho and OSnap; layers.

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

Lectures: 0 hours	**Tutorials: ---**	**Practice: 56 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	Draw orthographic sectional views of machine components.
CO 2	Read and depict tolerances in engineering drawings.
CO 3	Draw orthographic assembly views (simple and sectioned) of machine components.
CO 4	Use AutoCAD to create 2-D engineering drawings.

11. UNIT WISE DETAILS No. of Units: ___4_____

(Note: In this course, every week one session will be conducted in the manual drawing hall and one in the CAD lab. Some sheets can be done manually and some sheets using AutoCAD. Prior to starting of each sheet drawing, the concepts related to that specific machine component shall be explained to the students. Various machine components shall be covered in the course.)

Unit Number: 1 **No. of Lectures: 8** **Title:** Sectional views

Importance and application of sectional views; different types of sectional views

Unit Number: 2 **No. of Lectures: 6** **Title:** Tolerance

Content Summary: (In this unit, we will teach the students how to read and understand tolerances.) Importance of the topic; coordinate tolerancing; geometric tolerancing; gauging and measuring principles; material conditions (RFS, MMC, LMC); tolerance symbols

Unit Number: 3 **No. of Lectures: 14** **Title:** Assembly drawing

Content Summary: Applications of assembly drawing; types of assembly drawing; sectioning, dimensioning, and hidden lines in assembled views; standard parts in assembled views

Unit Number: 4 **No. of Lectures: 6** **Title:** 2-D CAD Drawing

Content Summary: Introduction to AutoCAD; draw toolbar; modify toolbar; Dimensioning toolbar; Properties toolbar; Ortho and OSnap; Layers

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

The main AutoCAD features and commands will be discussed in the class. The students need to learn further details of various menus in AutoCAD on their own.

14. Books Recommended :

Text Books:

Singh, A., "Machine Drawing – Includes AutoCAD", 2nd edition, Tata McGraw-Hill, 2010.

Reference Books:

Gill, P. S., "A Textbook of Machine Drawing", 18th edition, S K Kataria & Sons, 2013.

Reference websites:

www.autodesk.com

The practice part will have following components

Sr. No.	Topic	Cos covered
1.	Manual drawing on sectional views	1
2.	Manual drawing on sectional views	1
3.	Manual drawing on sectional views	1

4.	Tutorial on limits, fits and tolerances	2
5.	Tutorial on limits, fits and tolerances	2
6.	Manual Minor exam	1,2
7.	Manual drawing on limits, fits and tolerances	2
8.	Manual drawing on limits, fits and tolerances	2
9.	Manual drawing on assembly views	3
10.	Manual drawing on assembly views	3
11.	Manual drawing on assembly views	3
12.	Manual drawing on assembly views	3
13.	Manual drawing on assembly views	3
14.	Manual Major exam	1,2,3
15.	Practices on AutoCAD draw toolbar commands	4
16.	Practices on AutoCAD draw toolbar commands	4
17.	Practices on AutoCAD modify toolbar commands	4
18.	Practices on AutoCAD modify toolbar commands	4
19.	Practices on AutoCAD draw and modify commands	4
20.	Practices on AutoCAD layer toolbar commands	4
21.	Practices on AutoCAD dimension toolbar commands	4
22.	AutoCAD Minor exam	4
23.	Manual drawing on limits, fits and tolerances	2,4
24.	Manual drawing on limits, fits and tolerances	2,4
25.	Manual drawing on assembly views	3,4
26.	Manual drawing on assembly views	3,4
27.	Manual drawing on assembly views	3,4
28.	AutoCAD Major exam	1,2,3,4

COURSE TEMPLATE

1. Department /School :	Department of Mechanical Engineering		
2. Course Name: Machine Design - I	3. Course Code	4. L-T-P	5. Credits
	MEL207	3-1-0	4

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:** What is design? factors to be considered in design projects; phases of a design project; mission and requirements documents; design engineer's professional responsibilities; introduction to CAE; factor of safety; theories of static failure (Tresca, von Mises, modified Mohr); stress concentration; basics of statistics (Frequency distribution; measures of central tendency and dispersion; normal distribution); fatigue failure (fatigue test, S-N curve, Goodman's line); design of shafts and keys (design based on strength, design based on deformation, design of keys); selection of rolling contact bearings (types of rolling contact bearings, selection of deep groove ball bearings, reliability and life of bearings); design of belt drive systems (types of belts, design of flat and V belt systems); design of welded joints (types of weld, weld symbols, Butt and fillet weld calculations, welded joints under torsion and bending, weld inspection); Manufacturing considerations in design (casting, forging, machining, cold working, welding, DFMA)

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

Lectures: 42 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	Formulate requirements for a design project
CO 2	Estimate the life of a mechanical part under cyclic stresses
CO 3	Design shafts on the basis of design requirements such as strength, manufacturability, and cost
CO 4	Select rolling contact bearings for a given design problem based on requirements such as life, reliability, and cost
CO 5	Design belt drive systems on the basis of design requirements such as strength, market availability, and cost

CO 6	Design Butt and fillet welded joints.

11. UNIT WISE DETAILS No. of Units: ___7_____

Unit Number: 1 No. of Lectures: 5 Title: Introduction to engineering design

Introduction to the course; What is design? Factors to be considered in design projects; Phases of a design project; Mission and requirements documents; Design engineer's professional responsibilities; Introduction to CAE

Unit Number: 2 No. of Lectures: 9 Title: Static and fatigue failure

Content Summary: Theories of static failure (Tresca, von Mises, modified Mohr); stress concentration; basics of statistics (Frequency distribution; measures of central tendency and dispersion; normal distribution); fatigue failure (fatigue test, S-N curve, Soderberg's and Goodman's lines)

Unit Number: 3 No. of Lectures: 5 Title: Shaft design

Content Summary: Types of shafts; Types of keys; Manufacturing of shafts; Designing shafts based on strength; Designing keys; Designing shafts based on rigidity

Unit Number: 4 No. of Lectures: 5 Title: Selection of rolling contact bearings

Content Summary: Types of ball and roller bearings; installation of ball and roller bearings; selection of deep groove ball bearings

Unit Number: 5 No. of Lectures: 6 Title: Design of belt drives

Content Summary: Types of belts; Design of flat belt drives; Design of V belt drives; Installation and maintenance of belt systems

Unit Number: 6 No. of Lectures: 5 Title: Design of welded joints

Content Summary: Types of welding processes; types of welded joints; Weld symbols; Design of single Butt and fillet welds; Design of systems of Butt and fillet weld joints; Fatigue considerations; Weld inspection

Unit Number: 7 No. of Lectures: 2 Title: Design for manufacturing

Content Summary: Manufacturing considerations in design (casting, forging, machining, cold working, welding), DFMA basics

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

Designing shafts based on rigidity; Fatigue considerations in weld design

13. Books Recommended :
Text Books:

Bhandari, V.B., “Design of Machine Elements”, 4th edition, McGraw-Hill Education, 2016.

Reference Books:

1) Budynas and Nisbett, “Shigley’s Mechanical Engineering Design”, 9th edition, McGraw Hill Education, 2011.

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

3) Bhandari, V.B., “Machine Design Data Book”, McGraw-Hill Education, 2014.

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/

NPTEL Machine Design I: http://nptel.ac.in/courses/112105124/

NPTEL Machine Design II: http://nptel.ac.in/courses/112106137/

The practice part will have following components

Sr. No.	Topic	COs Covered
1	Brainstorming practice for generating ideas for product design	1
2	Class practice related to clarifying project requirements	1
3	Solving numericals on static failure	2
4	Presentation by students on mini-projects	1
5	Practice on data collection and statistical interpretation	2
6	Solving numericals on fatigue failure	2
7	Solving numericals on shaft design	3
8	Solving numericals on Selection of rolling contact bearings	4
9	Clearing doubts and solving problems on selected topics	all

10	Solving numericals on belt drive design	5
11	Solving numericals on weld design	6
12	Presentation by students on mini-projects	all
13	Presentation by students on mini-projects	all
14	Clearing doubts and solving problems on selected topics	all

COURSE TEMPLATE

1. Department:	**Department Mechanical Engineering**		
2. Course Name: Fluid Mechanics	**3. Course Code**	**4. L- T- P**	**5. Credits**
	MEL208	3-1-0	4
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:

Fluid Properties - Concept of fluid-flow, ideal and real fluids, properties of fluids, Newtonian and non-Newtonian fluids; **Fluid Statics** - Pascal's law, hydrostatic forces on bodies, stability of floating and submerged bodies; **Fluid Kinematics** - Eulerian and Lagrangian description of fluid flow; stream, streak and path lines, types of flows, continuity equation, rotation, vorticity and circulation, stream and potential functions; **Fluid Dynamics** - Concept of system and control volume, Euler's equation, Bernoulli's equation, correction factors, Impulse momentum relationship and its applications; **Laminar Flow** - Flow regimes and Reynolds number, analysis of uni-directional flow between parallel plates; **Flow through Pipes** - Losses in pipes, Hagen-Poiseuilli law, hydraulic gradient and total energy lines, series and parallel connection of pipes, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough pipes. **Boundary Layer Flow** (External Flows)- Concept, displacement, momentum and energy thickness, Von-Karman momentum integral equation, laminar and turbulent boundary layer flows, boundary layer separation and control, concept of drag and lift.

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

Lectures: 42 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

CO1	Analysis the various types of Fluid properties and its variations due to varying working conditions.
CO2	Analyze the Fluid at rest.
CO3	Analyze the various aspects of Fluid Kinematics.
CO4	Analyze the different aspects of Fluid Dynamics.
CO5	Analyze the various aspects of Laminar Flows through pipes.
CO6	Analyze the fluid flow through pipes and pipe fittings.
CO7	Analyze the various aspects of fluid flow near the solid boundary.

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

Unit Number: 1 **Title:** INTRODUCTION&FLUID PROPERTIES

Content Summary:

Concept of fluid-flow, ideal and real fluids, properties of fluids, Newtonian and non-Newtonian fluids.

Outcomes Covered: CO 1

Unit Number: **2** **Title:** FLUID STATICS

Content Summary:

Pascal's law, hydrostatic forces on bodies, stability of floating and submerged bodies.

Outcomes Covered: CO 2

Unit Number: **3** **Title:** FLUID KINEMATICS

Content Summary:

Eulerian and Lagrangian description of fluid flow; stream, streak and path lines, types of flows, continuity equation, rotation, vorticity and circulation, stream and potential functions.

Outcomes Covered: CO 3

Unit Number: **4** **Title:** FLUID DYNAMICS

Content Summary:

Concept of system and control volume, Euler's equation, Bernoulli's equation, correction factors, Impulse momentum relationship and its applications.

Outcomes Covered: CO 4

Unit Number: **5** **Title:** LAMINAR FLOW

Content Summary:

Flow regimes and Reynolds number, analysis of Uni-directional flow between parallel plates.

Outcomes Covered: CO 5

Unit Number: **6** **Title:** FLOW THROUGH PIPES

Content Summary:

Losses in pipes, Hagen-Poiseuilli law, hydraulic gradient and total energy lines, series and parallel connection of pipes, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough pipes.

Outcomes Covered: CO 6

Unit Number: **7** **Title:** BOUNDARY LAYER FLOW (External Flows)

Content Summary:

Concept of boundary layer growth over flat plate, displacement, momentum and energy thickness, Von-karman momentum integral equation, Analytical analysis of simple cases of laminar and turbulent boundary layer flows, boundary layer separation and control, concept of drag and lift.

Outcomes Covered : CO 7

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

Derivation of Pascal's Law; Manometers; Liquids in relative equilibrium; Continuity Equation in Cylindrical and Spherical Coordinates; Angular-Momentum Principle; First Law of Thermodynamics for control volume; Types of bearings; Drag and Lift on various shapes.

15. Books Recommended :

Text Books:

1. Cengel Y. A., "Introduction to Fluid Mechanics", Second Edition or above, McGraw Hill Education, 2013.
2. Frank White M., "Fluid Mechanics" 7th Edition SIE, McGraw-Hill Education, 2011.
3. Shames I H., "Mechanics of Fluids", Fourth Edition, Mc Graw Hill Education, 2003.

Reference Books:

1. Fox and Mcdonald, "Introduction to Fluid Mechanics", Fifth Edition or above, John Wiley & Sons Inc.,2008.
2. Som S.K., Biswas G., "Introduction to Fluid Mechanics and Fluid Machines", Second Edition, McGraw Hill Education,2008.
3. Agarwal S.K., "Fluid Mechanics and Machinery", McGraw - Hill Education, 2001

Reference websites:

1. www.nptel.ac.in
2. ocw.mit.edu

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	Cos covered
1.	Numerical solving on Fluid Properties and Statics.	Solution through interaction in class.	CO1 & CO2
2.	Numerical solving on Fluid Kinematics.	Solution through interaction in class.	CO3
3.	Numerical solving on Fluid Dynamics.	Solution through interaction in class.	CO4
Minor Test			
4.	Numerical solving on Laminar Flows.	Solution through interaction in class.	CO5
5.	Numerical solving on Flow through pipes.	Solution through interaction in	CO6

		class.	
6.	Numerical solving on Boundary layer flows.	Solution through interaction in class.	CO7
7.	Numerical solving on Boundary layer flows.	Solution through interaction in class.	CO7

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Material Science & Engineering	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL 209	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 Materials Science- Type of materials, Atomic Structure, Interatomic Bonding and Structure of Crystalline Solids, Crystal imperfections; Metallographic techniques of sample preparation; Mechanical Properties of metals- elastic and plastic deformations; Thermo-mechanical processing of metals and alloys; Phase diagrams; Heat treatment processes; Failure in materials-Ductile; Brittle Fracture and Fatigue, Creep and stress rupture; Types of materials systems-Metallic alloys, Ceramics, Polymeric and Composite materials, magnetic and diamagnetic materials; Corrosion- electrochemistry, types of corrosion; Oxidation; Characterization of materials- x-ray diffraction and scanning electron microscopy; Practical: Presenting demo model for crystal structures and imperfections in crystals, Metallographic techniques for sample preparation; microstructure observations of deformed and corroded samples under electron microscope; characterization and analysis of deformed specimens under both metallographic and electron microscope.

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

Lectures: 42 hours	**Tutorials: ---**	**Practical's: 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 fundamentals of material science and concepts of unit cell & crystallography.
CO 2	Illustrate different properties of materials and co-relate to the practical applications of different material.
CO 3	Apply different heat treatment processes according to their corresponding needs.
CO 4	Describe the basic properties of ceramics, composites and alloys with their applications.

11. UNIT WISE DETAILS No. of Units: ___4_____

Unit Number: 1 No. of Lectures: 10 Title: Introduction & Structure of Atoms & Molecules

Content Summary: Importance of materials. historical perspective, Brief review of modern; atomic concepts in Physics and Chemistry. Atomic models, Chemical bonding's. Crystallography and Imperfections: Concept of unit cell space lattice, Bravais lattices, common crystal structures, Atomic packing factor and density. Miller indices. Imperfections, Defects; Dislocations in solids.

.

Unit Number: 2 No. of Lectures: 7 Title: Mechanical properties and Testing

Content Summary: Stress strain diagram, Ductile; brittle material, Stress vs strength. Toughness, Hardness, Fracture, Fatigue and Creep. Phase Diagram and Equilibrium Diagram: Unary and Binary diagrams, Phase rules. Types of Phase diagrams. Iron-carbon equilibrium diagram.

Unit Number: 3 No. of Lectures: 6 Title: Heat Treatment

Content Summary: Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering and various case hardening processes. Time Temperature Transformation (TTT) diagrams

Unit Number: 4 No. of Lectures: 5 Title: Ceramics; Plastics, Magnetic Properties

Content Summary: Structure types and properties and applications of ceramics; Plastics. Properties of metallic alloys. Composite Materials and its uses. Brief theoretical consideration of Corrosion and its control. Magnetic and Diamagnetic materials: Properties and applications. Conducting Materials.

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

Type of materials, Atomic Structure, Interatomic Bonding and Structure of Crystalline Solids, Crystal imperfections Mechanical Properties of metals- elastic and plastic deformations, Failure in Materials-Ductile; Brittle Fracture and Fatigue, Creep. **Lab Project**

16. Books Recommended :
Text Books:

Balasubramaniam, R., "Callister's Materials Science and Engineering", 2nd edition, Wiley India, 2014

Reference Books:

1 Verlinden, B., Driver, J., et al., "Thermo-Mechanical Processing of Metallic Materials (Pergamon Materials Series)", Elsevier Science, 2007
2 Material Science and engineering by R.K Rajput Reprint 2009 S.K & Sons Publications.

Reference websites:

- http://nptel.ac.in/courses/112108150/

- http://qualifygate.com/download/s%20k%20mondal/Material%20Science%20IISc.pdf
- https://booksonweb.files.wordpress.com/2011/09/material-science-kakani-2004.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) • Introductory topics of the subject • Materials and their types • Atomic units and their types • Miller Indices	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Tutorial Sheet 1, Atomic Packing Efficiency	CO1
2.	• Grain Structures under Optical Microscope • Quiz	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in two groups, Practical will be conducted	CO2
Minor Test			
3.	• Structure of Pearlite, Bainite & Martensite • Quiz	• Tutorial Sheet 3, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO3
4.	• Alloys & Composite Materials (with some composite and alloy) • Observation of different Phase Structures using Microscope. • Self-Study	• 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	CO4

		demonstration	

Practical Content

Sr. No.	Title of the Experiment	Practical based/Model based	Unit covered	Time Required
10.	Crystal structure	**Model Based**	**1**	**100 min**
11.	Crystal Imperfection	**Model Based**	**1**	**100 min**
12.	Preparation of specimen for Impact Testing	**Practical based**	**2**	**200 min**
13.	Cutting of Specification	**Practical based**	**2**	**100 min**
14.	Polishing (DRY)	**Practical based**	**1**	**200 min**
15.	Polishing (WET)	**Practical based**	**2**	**100 min**
16.	Heat Treatment of Steel.	**Practical based**	**3**	**90 min**
17.	Water Quenching, Oil Quenching	**Practical based**	**3**	**90 min**
18.	Heat Treatment of Impact Specimen	**Practical based**	**3**	**90 min**

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

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Heat and Mass Transfer	**3. Course Code**	**4. L-T-P**	**5. Credits**
	Code: MEL 202	3-0-2	4
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: Basic laws of Heat & Mass transfer; General conduction equations in Cartesian, Cylindrical and Spherical coordinates; Steady state heat conduction with and without heat generation, Electrical analogy, Critical thickness of insulation, Fins; Unsteady heat conduction, lumped analysis; Governing equations for Convective heat transfer, Thermal boundary layer; Forced convection, convection equation; Free convection; Boiling and condensation; Heat exchangers; Thermal radiations; Electrical network method; Radiation shields; Heat and mass transfer analogy; Mass diffusion equation.

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

Lectures: 42 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 develop understanding about various modes of heat transfer and governing laws
CO 2	To solve steady state and transient heat conduction problems
CO 3	To analyze heat transfer through fins and shell & tube heat exchanger.
CO 4	To select suitable empirical correlations for solving free, forced & phase change convection problems
CO 5	To analyze radiation heat transfer from an ideal & real surface
CO 6	To analyze mass diffusion problems

11. UNIT WISE DETAILS No. of Units: 9

Unit Number: 1 **No. of Lectures: 3** **Title:** Basic laws of Heat & Mass transfer

Content Summary: Modes of Heat Transfer; Basic Laws of heat & mass transfer

Unit Number: 2 No. of Lectures: 8 Title: Steady State Conduction without Heat Generation

Content Summary: Introduction, general conduction equation in Cartesian, cylindrical and spherical coordinates, Steady one dimensional heat conduction without internal heat generation; The plane slab; The cylindrical shell; The spherical shell; Variable thermal conductivity, Electrical Analogy of heat conduction; Conduction through plane and composite Walls; Overall heat transfer coefficient, Critical thickness of insulation; Fins of uniform cross section; Governing equation; Temperature distribution and heat dissipation rate; Efficiency and effectiveness of fins

Unit Number: 3 No. of Lectures: 3 Title: Steady State Conduction without Heat Generation

Content Summary: Steady one dimensional heat conduction with uniform internal heat generation in the plane slab; Cylindrical and spherical systems

Unit Number: 4 No. of Lectures: 4 Title: Transient Heat Conduction

Content Summary: Lumped capacitance analysis, transient heat conduction in plane wall, cylinders, spheres with convective boundary conditions, Chart solution.

Unit Number: 5 No. of Lectures: 7 Title: Convection

Content Summary: Newton's law of cooling, Convective heat transfer coefficient; Free and forced convection and associated correlations; Governing equations; thermal boundary layer; Reynolds analogy, Various dimensionless numbers: Reynolds, Prandtl, Nusselt, Grashoff; Overall heat transfer Coefficient.

Unit Number: 6 No. of Lectures: 3 Title: Boiling and Condensation

Content Summary: Laminar film condensation on a vertical plate, Drop-wise condensation, Boiling Regimes, Nucleate and film boiling.

Unit Number: 7 No. of Lectures: 4 Title: Heat Exchangers

Content Summary: Introduction; Classification of heat exchangers; Logarithmic mean temperature Difference; analysis of parallel and counter flow heat exchangers; Effectiveness of heat exchangers; N T U method for heat exchanger design; Applications of heat exchangers

Unit Number: 8 No. of Lectures: 7 Title: Thermal Radiation

Content Summary: Thermal radiation; Absorption, Reflection and transmission, Monochromatic and total emissive power; Black body concept; Planck's distribution law; Stefan Boltzmann law; Wien's displacement law; Lambert's cosine law; Kirchhoff's law; Shape factor; Heat transfer between black and gray surfaces by electric network method, Radiation shields

Unit Number: 9 No. of Lectures: 3 Title: Mass Transfer

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

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

1. Boiling and Condensation

2. Virtual Lab Experiments on Heat Transfer

12. Books Recommended :

Text Books:

1. Fundamentals of Heat and Mass Transfer by Frank P. Incropera, Wiley
2. Heat and Mass Transfer by P.K Nag, TMH
3. Heat and Mass Transfer by Y. A. Cengel, Mc Graw Hill, 5th Edition

Reference Books:

1. Heat Transfer by J P Holman, Tata McGraw Hill

Reference Website: NPTEL (nptel.ac.in)

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 • Numerical on basic laws of heat transfer	• Basic questions related to the introductory part of the subject • Tutorial Sheet 1, Doubt clearance	CO1
2.	• Numerical on steady state 1-D without internal heat generation	• Tutorial Sheet 2, Doubt clearance	CO2
3.	• Numerical on steady state 1-D with internal heat generation	• Tutorial Sheet 3, Doubt clearance	CO2
4.	• Numerical on transient heat conduction and performance of fins	• Tutorial Sheet 4, Doubt clearance	CO2, CO3
Minor Test			
5.	• Numerical on convection heat	• Tutorial Sheet 5, Doubt	

	transfer	clearance	CO4
6.	• Numerical on heat exchangers	• Tutorial Sheet 6, Doubt clearance	CO3
7.	• Numerical on radiation heat transfer	• Tutorial Sheet 7, Doubt clearance	CO5
8.	• Numerical on mass diffusions	• Tutorial Sheet 8, Doubt clearance	CO6

Practical Content

Sr. No.	Title of the Experiment	Performance based/ Software based	Unit covered	Time Required
1.	To determine the coefficient of thermal conductivity of a given asbestos sheet by Guarded hot plate method at different temperatures and to draw a plot between conductivity and temperature	**Performance based**	**1, 2**	**90 min**
2.	To determine the temperature profile along the axis of a given circular fin experimentally and theoretically under free convection and to compare the two temperature profiles in free convection. Also determine the efficiency of the fin.	**Performance based**	**1, 2**	**90 min**
3.	To determine the temperature profile along the axis of a given circular fin experimentally and theoretically under forced convection and to compare the two temperature profiles in both free and forced convection. Also determine the efficiency of the fin.	**Performance based**	**1, 2**	**90 min**
4.	To determine the convective heat transfer coefficient on a vertical cylinder exposed to natural convection. Also to plot the temperature profile along the length of the cylinder.	**Performance based**	**1, 5**	**90 min**
5.	To determine the convection heat transfer coefficient between hot air and inner surface of a tube in forced convection and compare these	**Performance based**	**1, 5**	**90 min**

	experimental values of convective heat transfer coefficient with the predicted values.			
6.	To study the construction of a parallel flow heat exchangers and to find overall heat transfer coefficient as a function of mass flow rate of water. Also calculate the effectiveness of the heat exchangers.	**Performance based**	**7**	**90 min**
7.	To study the construction of a counter flow heat exchangers and to find overall heat transfer coefficient as a function of mass flow rate of water. Also calculate the effectiveness of the heat exchangers.	**Performance based**	**7**	**90 min**
8.	To determine the emissivity of a test surface and plot a graph between temperature and emissivity	**Performance based**	**1, 8**	**90 min**
9.	To determine the value of Stefan Boltzmann Constant, used in radiation heat transfer. Draw a graph also between temperature of disc and time	**Performance based**	**1, 8**	**90 min**

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Instrumentation and Control Engineering	**3. Course Code**	**4. L- T-P**	**5. Credits**
	MEL326	3-0-2	4
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 of Instruments and their types, standards and their calibration, static and dynamics characteristics of instruments, , first and second order systems: transient and frequency response, error and uncertainties in performance parameters, transducers, digital logic number system, signal conditioners, Data acquisition system, introduction to control systems, transfer function of the systems, sequence control, stability check using Routh, root locus, Bode and Nyquist method, Fundamentals of vibration, free, damped and forced vibrations for single DOF system.

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

Lectures: 42 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 the different types of instruments used in the industries.
CO 2	Plan and design the measuring instruments.
CO 3	Design a controller for industrial application.
CO 4	Examine the stability of experimental set-up.

10. UNIT WISE DETAILS No. of Units: ___6_____

Unit Number: 1 No. of Lectures: 7 Title: Introduction to Instruments

Content Summary: Introduction of Instruments and their types, standards and their calibration.

Unit Number: 2 No. of Lectures: 9 Title: Static and Dynamic characteristics of instruments **Content Summary:** Static and dynamics characteristics of instruments, error and uncertainties in performance parameters.
Unit Number: 3 No. of Lectures: 8 Title: Transducers **Content Summary:** Various types of Transducers used in industry, Signal conditioners, Data acquisition system.
Unit Number: 4 No. of Lectures: 12 Title: Introduction to controls **Content Summary:** Introduction to controllers, first and second order systems: transient and frequency response, transfer function of the system & process.
Unit Number: 5 No. of Lectures: 2 Title: Stability **Content Summary:** Stability check using routh, root locus, bode and nyquist method
Unit Number: 6 No. of Lectures: 4 Title: Vibrations **Content Summary:** Fundamentals of vibration, free, damped and forced vibrations for single DOF system.
12. Brief Description of Self-learning component by students (through books/resource material etc.): Performance of strain gauge under no load and loading conditions, mathematical modeling of first order and second order systems, basic logic gates, **Lab Project**
13. Books Recommended : **Text Books**: 1. Nakra, B.C., Chaudhry, K.K., "Instrumentation, Measurement and Analysis", McGraw Hill Education, 4th edition, 2016 **Reference Books**: 1. Ogata K, "Modern Control Engineering", Pearson Education, 5th edition, 2009 **Reference websites:** http://nptel.ac.in/courses/108105063/

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	Cos covered
1.	• Numerical on uncertainties of 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, Doubt clearance	CO1
2.	• Numerical on transfer function of systems	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO3
Minor Test			
3.	• Numerical on dynamic characteristics of instruments	• Tutorial Sheet 3, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO2
4.	• Numerical on vibrations	• 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	CO4

Practical Content

Sr. No.	Title of the Experiment	Software/Kit based/Component based	Unit covered	Time Required
1.	To measure displacement using LVDT	**Hardware based**	**3**	**90 min**
2.	To measure load using load cells	**Hardware based**	**3**	**90 min**

3.	To measure torque using torque transducer	**Hardware based**	**3**	**90 min**
4.	To measure temperature using thermocouple	**Hardware based**	**3**	**90 min**
5.	Perform experiments for data acquisition system	**Hardware based**	**2**	**90 min**
6.	Transient response of first order system	**Hardware based**	**2**	**90 min**
7.	Transient response of second order system	**Hardware based**	**2**	**90 min**
8.	Stability criterion check using MATLAB	**Hardware based**	**5**	**90 min**

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

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Industrial Engineering	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL310	3-1-0	4
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: This subject deals with industrial safety, Productivity, Work Study, Plant Location and Layout, Material Handling and ergonomics, Production systems and their characteristics, systems analysis, Sequencing and scheduling; Inventory, Quality Management, Value Engineering- Value engineering, waste management; Selected topics- Introduction to Lean Systems, Value Stream Mapping, SMED, Total Productive Maintenance, the big losses and OEE.

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

Lectures: 42 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	Carry out and apply the techniques for industrial processes.
CO 2	To select appropriate techniques for solving the problems related to industrial engineering.
CO 3	Analyze the industrial processes and improve the same.
CO 4	To apply the latest trends in the real time.

11. UNIT WISE DETAILS No. of Units: ___3_____

Unit Number: 1 No. of Lectures: 12 Title: Introduction IE and Production systems

Introduction to the need of IE with IE Gurus. Plant Location, Plant Layout and Material Handling. Production systems and their characteristics.

Unit Number: 2 No. of Lectures: 8 Title: Work study

Content Summary: Method Study and Work measurement.

Unit Number: 3 No. of Lectures: 8 Title: Inventory Management **Content Summary:** Forecasting techniques, Inventory Control, Models and applications.
Unit Number: 4 No. of Lectures: 8 Title: Quality Management **Content Summary:** 7 QC tools, Control charts and Process capability. Sequencing and scheduling
Unit Number: 5 No. of Lectures: 6 Title: Special Topics **Content Summary:** Total Productive Maintenance the big losses and OEE. Selected topics –Introduction to Lean Systems, Value Stream Mapping, SMED, Six Sigma and TPS.
12. Brief Description of Self-learning component by students (through books/resource material etc.): Special casting, welding and forming processes, **Lab Project**
13. Books Recommended : **Text Books**: 1. Martand Telsang, "Industrial Engineering and Management", standard publisher. **Reference Books**: 1. Pravin Kumar., "Industrial Engineering and Management" 1st edition, Pearson Education India, 2015 2. **Reference websites:** 3. http://nptel.ac.in/courses/112107142/ 4. http://nptel.ac.in/courses/112107143/ 5. LMS

The practice part will have following components

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) • Method Study and time study	• 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.	• Work Measrurement	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	

			CO3
Minor Test			
3.	• Plant location and layout	• Tutorial Sheet 3, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO2
4.	• Inventory management	• Tutorial Sheet 4, Doubt clearance •	CO3 CO4
5.	• Quality Management	• Tutorial Sheet 5, 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

1.	**Lab Project(To be allotted at the start of the semester)**	Mini project based on casting welding forming.	Semester

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Machine Design II	**3. Course Code**	**4. L-T- P**	**5. Credits**
	Code: MEL328	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: Selection of fits and tolerances (types of fits, fit symbols, fit selection guidelines, selective assembly); Design of bolted joints (types of bolts and screws, standards and terminology, failure modes, critical stresses, preloading effects, tightening torque, systems of bolts under torsion and bending); Design of springs (types and applications, spring materials, manufacturing process, design of helical springs, buckling and surge considerations); Design of gears (types and applications, spur gear tooth profile, gear manufacturing, stress analysis of spur gears, lubrication, design based on tooth bending strength, design based on surface durability); Design for corrosion control (chemistry of corrosion, electrode and electrolyte heterogeneity, techniques to control corrosion, corrosion plus static loads, corrosion plus cyclic loads); Design of clutches (types of clutches, torque transmitting capacity, clutch materials, energy and thermal considerations)

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	Select fits and tolerances for simple assembly systems.
CO 2	Design bolted joints.
CO 3	Design helical springs.
CO 4	Design spur gear systems.
CO 5	Give basic solutions to control corrosion in a given application.
CO 6	Design simple clutch systems

11. UNIT WISE DETAILS No. of Units: ___6_____

Unit Number: 1 No. of Lectures: 3 Title: Selection of fits and tolerances

Meaning of fit and tolerance and their importance, types of fits, fit symbols, fit selection guidelines, selective assembly

Unit Number: 2 No. of Lectures: 6 Title: **Design of bolted joints**

Content Summary: Types of threaded joints; Terminology and standards of screw threads; failure modes, critical stresses, preloading effects; Torque requirements for bolt tightening; Design considerations for gasketed joints; Design of systems of bolts under torsion and bending; design of bolted joints under fluctuating loads

Unit Number: 3 No. of Lectures: 5 Title: Design of springs

Content Summary: Types of springs; terminology of helical springs; spring materials and manufacturing processes; Design of helical springs for static loads; Design of helical springs for fluctuating loads; buckling and surge considerations

Unit Number: 4 No. of Lectures: 6 Title: Design of gears

Content Summary: Types of gears; tooth profile; contact ratio; interference; Manufacturing of gears; stress analysis of spur gears, lubrication; Design of spur gears based on tooth bending; Design of spur gears based on tooth wear

Unit Number: 5 No. of Lectures: 3 Title: Design for corrosion control

Content Summary: chemistry of corrosion; electrode and electrolyte heterogeneity; General guidelines for corrosion control; Effect of static loads; Effect of cyclic loads

Unit Number: 6 No. of Lectures: 3 Title: Clutch design

Content Summary: Types of clutches, Torque transmitting capacity, Clutch materials, Energy and thermal considerations

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

Design of bolted joint systems under bending, Design of helical springs for fluctuating loads

13. Books Recommended :

Text Books:

1. Bhandari, V.B., “Design of Machine Elements”, 4th edition, McGraw Hill Education, 2016.

Reference Books:

1. 1) Budynas and Nisbett, “Shigley’s Mechanical Engineering Design”, 9th ed., McGraw Hill Education, 2011.

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

3) Bhandari, V.B., “Machine Design Data Book”, McGraw-Hill Education, 2014.

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://nptel.ac.in/courses/112105124/

http://nptel.ac.in/courses/112106137/

The practice part will have following components

Sr. No.	Topic	Cos covered
1.	Solving numericals related to tolerance and fit design	1
2.	Solving numericals related to selective assembly	1
3.	Solving numericals related to design of bolted joints	2
4.	Solving numericals related to design of bolted joints	2
5.	Solving numericals related to design of springs	3
6.	Presentation by students on mini-projects	all
7.	Presentation by students on mini-projects	all
8.	Solving numericals on gear design	4
9.	Solving numericals on gear design	4
10.	Case studies and class discussion on corrosion	5
11.	Presentation by students on mini-projects	all
12.	Presentation by students on mini-projects	all
13.	Clearing doubts and solving problems on selected topics	all

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: OPERATIONS RESEARCH	**3. Course Code**	**4. L-T- P**	**5. Credits**
	Code: MEL 401	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: Role of operations research in decision making, applications in industry; concepts in OR model building; Linear programming: Graphical method and Simplex methods, BIG-M and Two phase methods; computational problems; Allocation models: Transportation and Assignment problems; Advanced topics of linear programming: Duality, Primal-Dual relations, sensitivity analysis, dual simplex method; Simulation models, Monte Carlo technique and its applications, Waiting line theory and its applications; Software tools for Operations Research

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	Acquire knowledge to identify and develop operational research models from the verbal description of the real life process planning problems.
CO 2	Develop and apply various mathematical algorithms to solve decision-making problems of various domains by the use of analytic skills to evaluate, analyze the challenges and propose recommendations in a language understandable to the decision-making processes in Management Engineering.
CO 3	Apply the concepts of assignment algorithms to assign jobs to the machines systematically to minimize transportation cost between the supplier & parent company by selecting the optimum route using different models.
CO 4	Analyze and make business decisions about the resources needed to provide a service, to predict wait times and number of customer/product arrivals rate in an assembly line.

11. UNIT WISE DETAILS No. of Units: ___5_____

Unit Number: 1 No. of Lectures: 4 Title: Introduction to Operation Research

Introduction: Developments, Definitions, objectives and characteristics of O.R, Role of operations research in decision making, scope of OR in manufacturing industry, concepts in OR model building.

Unit Number: 2 No. of Lectures: 7 Title: Linear programming

Content Summary: Requirements for linear programming, important terms, Examples on the applications of linear programming, Graphical solutions of two variable LP problems and simplex methods to solve LP problems: BIG-M and Two phase methods. Special cases in simplex problems.

Unit Number: 3 No. of Lectures: 9 Title: Allocation models

Content Summary: Definition, Matrix terminology, formulation and solutions of transportation models by using N-W, Matrix minima, VAM and MODI algorithms. Definition of assignment model, comparison with transportation model, formulation and solutions of assignment model, special cases of assignment problems like Travel salesman problems.

Unit Number: 4 No. of Lectures: 2 Title: Advanced topics of linear programming

Content Summary: Duality, Primal-Dual relations, sensitivity analysis, dual simplex method

Unit Number: 5 No. of Lectures: 6 Title: Simulation and Waiting line models

Content Summary: Introduction, When to use simulation, advantages of simulation technique, Characteristics of queuing models, models on queuing and numerical, Monte Carlo technique applied to queuing problems and its applications, Software tools for O.R.

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

Self learning component includes primal dual problems, Simulation technique through online sources like nptel, Video lectures etc.

13. Books Recommended :

Text Books:

1) J K Sharma, “Operations Research: Theory and Applications”, 4th Edition, Macmillan Publishers India ltd, 2009.

2) Hamdy A. Taha, “Operation Research: An introduction”, 8th edition, Pearson publication House, 1997.

Reference Books:

1) Kanti Swarup, P.K. Gupta , “Operations Research”, Sulthanchand publishers, 2010.

2) Kirshna's Operations Research- Dr. R. K. Gupta, Krishna Prakashan Media , 2014.

Reference websites:

http://home.ubalt.edu/ntsbarsh/opre640online/opre640online.htm
http://lmsncu.ncuindia.edu/course/view.php?id=190

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 • Numericals on problem Formulation • Numericals on Formulation and Graphical method	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Tutorial Sheet 1 and 2, Doubt clearance	CO1
2.	• Numericals on Simplex method • Numericals on TWO phase and Big-M Method • Numericals on Transportation: Matrix minima, N-W corner, VAM • Quiz	• Tutorial Sheet 3 and 4, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO2
Minor Test			
3.	• Numericals on Transportation: Optimization methods : MODI, Stepping stone method, concept of degeneracy • Quiz	• Tutorial Sheet 5 and 6 , Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO3
4.	• Numericals on Assignment: Minimization, Maximization, travelling salesman, degeneracy • Numericals on Waiting line on all 4 MODELS • Numericals on Simulation models, Monte Carlo	• Tutorial Sheet 7 and 8 , Doubt clearance • Assignment (Discussion and presentation on self-study topics by the students and	CO4

	technique • Self-study topics • Case studies/real life examples	addressing the problems given in assignment) • Through discussion, Presentation or video demonstration	

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: I C Engines and Gas Turbines	**3. Course Code**	**4. L- T -P**	**5. Credits**
	Code: MEL 312	2-0-2	4
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: Engine types and their operation: CI and SI; Engine operating and performance parameters; Analysis of air standard, fuel-air cycle, and actual cycle, Comparison of Otto, Diesel and Dual cycle; Fuels for Internal Combustion Engines: Conventional and alternative fuels; Combustion in SI and CI Engines; Fuel Injection System for SI and CI Engines; Ignition system for SI engines; Turbo-charging and super-charging; Engine Cooling; Engine Lubrication; Emissions: Types of emissions and their control; Gas Turbines: Brayton cycle, efficiency improvements, Types of Gas turbines engines: Turbojet, turbofan and turboprop gas turbine engines.

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 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, Dual and Brayton Cycle
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	Demonstrate an understanding of the relationships between the design of the IC engine and environmental and social issues
CO 6	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.

11. UNIT WISE DETAILS No. of Units: 9

Unit Number: 1 No. of Lectures: 4 Title: Engine Types and their Operations

Content Summary: Classification of I.C. Engines; Cycle of operations in four strokes and two-stroke IC engines; Wankle Engine; Engine Components; Spark Ignition engine operation, examples of SI engines; Compression Ignition Engine operation, examples of CI engines. Fuels for ICE engines: Gasoline, Diesel, Ethanol and compressed Natural Gas

Unit Number: 2 No. of Lectures: 4 Title: Performance Parameters

Content Summary: BHP, IHP, Mechanical efficiency; Brake mean effective pressure and indicative mean effective pressure, Torque, Power, Volumetric efficiency; Specific fuel consumption (BSFC, ISFC); Thermal efficiency; Heat balance; Basic engine measurements; Fuel and air consumption, Brake power, Indicated power and friction power, Heat lost to coolant and exhaust gases; Performance curves

Unit Number: 3 No. of Lectures: 7 Title: Cycles and their analysis

Content Summary: Assumptions made in air standard cycles; Otto cycle; Diesel cycle; Dual combustion cycle; Comparison of Otto, diesel and dual combustion cycles; Sterling and Ericsson cycles; Deviation of actual engine cycle from ideal cycle; Air – fuel cycles, Actual cycles.

Unit Number: 4 No. of Lectures: 7 Title: Fuel Injection Systems

Content Summary: Mixture requirements for various operating conditions in S.I. Engines; Gasoline Injection Systems: Elementary carburetor, Multi point fuel injection system, gasoline direct injection system; Requirements of a diesel injection system; In-line fuel injection system, common rail direct injection systems, injectors; Requirements of ignition system; Types of ignition systems, ignition timing; Spark plugs. S.I. engines; Ignition limits

Unit Number: 5 No. of Lectures: 8 Title: Combustion in SI & CI Engines

Content Summary: Stages of combustion in S. I. Engines; Ignition lag; Velocity of flame propagation; Detonation; Effects of engine variables on detonation; Theories of detonation; Octane rating of fuels; Pre-ignition; S.I. engine combustion chambers. Stages of combustion in C.I. Engines; Delay period; Variables affecting delay period; Knock in C.I. Engines; Cetane rating; C.I. Engine combustion chambers.

Unit Number: 6 No. of Lectures: 3 Title: Engine Emissions and their control

Content Summary: The current scenario on the pollution front; Emission Norms; Pollutants from S.I. and C.I. Engines; Methods of emission control.

Unit Number: 7 No. of Lectures: 5 Title: Engine Cooling and Lubrication

Content Summary: Heat Transfer; Piston and Cylinder temperature; Air Cooling; Liquid Cooling; Radiators; Lubrication principle; Functions of Lubrication system; Properties of Lubricating oil; Classification of lubricating systems

Unit Number: 8 No. of Lectures: 4 Title: Gas Turbines

Content Summary: Brayton cycle; Components of a gas turbine; Open and closed types of gas turbine plants; Optimum pressure ratio; Improvements of the basic gas turbine cycle; Multi stage compression

with inter-cooling; Multi stage expansion with reheating between stages; Exhaust gas heat exchanger; Application of gas turbines.

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

3. Wankel Engine
4. Fuel Injection Systems
5. VTi, VVT, VTVT, VTEC, DTEC Technologies
6. Alternative Fuels
7. Standards for Emission of Pollutants from Motor Vehicle as per Central motor Vehicles Rules

13. Books Recommended :

(a) Text Books:

1. V. Ganesan, "Internal Combustion Engines", Fourth Edition McGraw-Hill.

2. M.L. Mathur and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai & Sons.

(b) Reference Books:

1. J.B. Heywood, "Internal Combustion Engines", McGraw-Hill.

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 • Numerical on performance parameters- ip, bp, sfc, thermal efficiency	• Basic questions related to the performance parameters of the engine • Tutorial Sheet 1, Doubt clearance	CO1, CO2
2.	• Numerical on performance parameters- ip, bp, sfc, thermal efficiency	• Tutorial Sheet 2, Doubt clearance	CO1, CO2
3.	• Numerical on calculation of thermal efficiency, work output & mean effective pressure of Otto cycle, Diesel cycle	• Tutorial Sheet 3, Doubt clearance	CO3
4.	• Numerical on calculation of thermal efficiency, work output & mean effective pressure of Dual cycle,	• Tutorial Sheet 4, Doubt clearance	

	Efficiency of Brayton cycle		CO3
Minor Test			
5.	• Presentation on Wankel Engine	• Presentation	CO1
6.	• Presentation on VVT, VVTi, V-Tech technologies	• Presentation	CO1
7.	• Presentation on engine cooling system, Radiator	• Presentation	CO4
8.	• Presentation on engine emissions	• Presentation	CO4

Practical Content

Sr. No.	Title of the Experiment	Performance based/ Software based	Unit covered	Time Required
1.	To study the constructional details and working principles of two stroke and four stroke petrol engine	**Performance based**	**1, 2, 3**	**90 min**
2.	Study the constructional details and working principles of two/four strokes diesel engines	**Performance based**	**1, 2, 3**	**90 min**
3.	To prepare heat balance sheet of a multi-cylinder diesel engine	**Performance based**	**1, 2**	**90 min**
4.	To find the indicated power of multi-cylinder four strokes MPFI petrol engine by Morse test and determine the mechanical efficiency-	**Performance based**	**2**	**90 min**

5.	To perform variable speed performance test of a multi-cylinder petrol engine and prepare the curves (i) BP, v/s speed (ii) brake specific fuel consumption v/s speed	**Performance based**	**2**	**90 min**
6.	To find FHP of a two-cylinder diesel engine by William's line method	**Performance based**	**2**	**90 min**
7.	To perform constant speed performance test on a single cylinder diesel engine and draw curves of (i) bp vs. fuel rate (ii) bp vs air rate (iii) bp vs. mechanical efficiency (iv) BP vs bsfc	**Performance based**	**2**	**90 min**
8.	To perform variable speed performance tests of a two-stroke petrol engine and prepare the curves (i) bp, vs speed (ii) bsfc vs speed	**Performance based**	**1, 2**	**90 min**
9.	To study the working of Gas Analyser and measure exhaust gas of a motor vehicle using Exhaust Gas Analyzer (AVL DiGas 444)	**Performance based**	**6**	**90 min**

1.	**Lab Project(To be allotted at the start of the semester)**		Semester

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Energy, ecology and environment	**3. Course Code** **Code:** MEL 482	**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: Ecosystem, Environment pollution, Carbon Footprint, global warming and climate change, Ecology, Structure and functioning of natural ecosystems, Natural resources, Agricultural, industrial systems and environment, Energy technologies and environment, 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 correlate major local and regional environmental issues with changes in ecology and human health.
CO 2	To monitor and document the development and dynamics of ecosystems in experimental or natural microcosms.
CO 3	To define and document local resource consumption patterns and conservation strategies.
CO 4	To define opportunities available for energy conservation and for use of renewable energy resources in local and regional entities.

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

Unit Number: 1 **No. of Lectures: 4** **Title: Environment pollution, global warming and climate change**

Content Summary: Air pollution (local, regional and global); Water pollution problems; Land pollution and food chain contaminations; Carbon cycle, greenhouse gases and global warming; Climate change – causes and consequences; Carbon footprint; Management of greenhouse gases at the source and at the sinks

Unit Number: 2 **No. of Lectures: 6** **Title: Ecology, Structure and functioning of natural ecosystems**

Content Summary: Ecology, ecosystems and their structure, functioning and dynamics; Energy flow in ecosystems; Biogeochemical cycles and climate; Population and communities

Unit Number: 3 **No. of Lectures: 6** **Title: Natural resources**

Content Summary: Human settlements and resource consumption; Biological, mineral and energy resources; Land, water and air; Natural resources vis-à-vis human resources and technological resources; Concept of sustainability; Sustainable use of natural resources

Unit Number: 4 **No. of Lectures: 6** **Title: Agricultural, industrial systems and environment**

Content Summary: Agricultural and industrial systems vis-à-vis natural ecosystems; Agricultural systems, and environment and natural resources; Industrial systems and environment

Unit Number: 5 **No. of Lectures: 8** **Title: Energy technologies and environment**

Content Summary: Electrical energy and steam energy; Fossil fuels, hydropower and nuclear energy; Solar energy, wind energy and biofuels; Wave, ocean thermal, tidal energy and ocean currents; Geothermal energy; Future energy sources; Hydrogen fuels; Sustainable energy.

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

Solar heating systems; Solar power plants; Thermal power plants; Hydroelectric power plants; Biofuels;

Environmental status assessments; Energy status assessments.

13. Contextual learning component(s)

Videos and assignments related to Sanitary landfill systems; e-waste management; Municipal solid waste management; Biodiversity and biopiracy; Air pollution control systems; Water treatment systems; Wastewater treatment plants;

14. Books Recommended:

Text Books:

1) Bharucha, E., Textbook of Environmental Studies, Universities Press (2005).

2) Chapman, J.L. and Reiss, M.J., Ecology-Principles and Application, Cambridge University Press (LPE) (1999).

3) Wright, R.T., Environmental Science-Towards a sustainable Future, Prentice Hall (2008) 9thed.

Reference Books:

1) Joseph, B., Environmental Studies, Tata McGraw-Hill (2006).

2) Eastop, T.P. and Croft, D.R. Energy Efficiency for Engineers and Technologists, Longman and Harow (2006).

3) Miller, G.T., Environmental Science- Working with Earth, Thomson (2006).

Reference websites:

NPTEL online courses

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	• By providing information about LMS where the	CO1

	scheme • Explaining course outcomes(Cos) • Introductory topics of the subject • Environment, • Ecosystem, Biomes • Natural resources • Film Analysis on related topics	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 •	
2.	3. Pollution & control	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO2
Minor Test			
4.	• Agricultural, industrial systems • Renewable energy systems • Sustainable energy systems	• Tutorial Sheet 3, Doubt clearance	CO3
5.	Self-study topics: Solar heating systems; Solar power plants; Thermal power plants; Hydroelectric power plants; Biofuels; waste management	• Tutorial Sheet 4, 5 &6 • 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 renewable energy systems on campus	Study based	All
2.	Written reports /case studies on waste management in Indian cities.	Study based	All

3.	Sustainable energy design project.	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: Heating, Ventilation and Air Conditioning	**3. Course Code**	**4. L-T-P**	**5. Credits**
	Code: MEL 483	2- 1 - 2	4
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: Refrigerating machine; Reversed Carnot cycle; Air refrigeration; Simple vapour compression refrigeration; Actual vapour compression cycle; Multi pressure vapour compression systems; Low temperature refrigeration; Constructional study of commercial applications of Vapour compression Refrigeration: Refrigerants; Vapour absorption refrigeration; Steam jet refrigeration; Psychometry of Air-conditioning processes and comfort conditions; Air-conditioning systems; Estimation of cooling and heating loads.

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

Lectures: 28 hours	**Tutorials: 14**	**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 Understand the principles of HVAC
CO 2	To calculate cooling load for different application.
CO 3	Understand P-h diagram and basic principles of VCR system
CO 4	To select right equipment for a particular application.
CO 5	To design and implement heating, ventilation and air conditioning system using standards.
CO 6	Understand the concept of indoor environmental comforts.

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

Unit Number: 1 **No. of Lectures: 3** **Title: Introduction to Heating, ventilation & air Conditioning**

Content Summary: Recapitulation of thermodynamic laws & processes, History of refrigeration, Heat Engine-Heat Pump-Refrigerating machine, Difference b/w refrigeration & air conditioning, unit of refrigeration, COP, Reversed

Carnot cycle and its limitations, Difference b/w vapor and gas as a refrigerant

Unit Number: 2 No. of Lectures: 4 Title: Air Refrigeration Cycle

Content Summary: Air refrigeration cycles - Brayton refrigeration, Necessity of air craft refrigeration, Types of air craft refrigeration systems and their comparison.

Unit Number: 3 No. of Lectures: 11 Title: Vapor Compression refrigeration & AC systems

Content Summary: Simple VCR system, Types of VCRS and their analysis, Actual VCRS, Effects of operating conditions on COP, Methods to improve simple VCR, Need for multi stage VCRS, Two stage VCR with intercooler, VCRS with single compressor and multiple evaporators, VCRS for low temperature applications (Cascaded VCR system)

Unit Number: 4 No. of Lectures: 1 Title: Refrigerants

Content Summary: Properties of an ideal refrigerant, classification of refrigerants and their nomenclature. Various thermodynamic, chemical and physical properties of refrigerants.

Unit Number: 5 No. of Lectures: 3 Title: Other HVAC Systems

Content Summary: Vapor absorption refrigeration, VCR versus VAR, COP of an ideal VAR, three fluid VAR, Jet refrigeration system

Unit Number: 6 No. of Lectures: 4 Title: Psychometry, heating & air Conditioning Process

Content Summary: Psychrometric terms and relations, psychrometric chart and processes, by-pass factor. Air Washer, Adiabatic Saturation. Summer and winter Air conditioning, Types of air conditioning systems.

Unit Number: 7 No. of Lectures: 2 Title: Ventilation and air Conditioning Load estimation

Content Summary: Outside and inside design, Sources of heating and cooling load conditions, Heat transfer through structure, solar, electrical and ventilation, apparatus selection, comfort chart

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

Different types of refrigerant and their applications, Window air conditioning system, split air conditioning system**,** air conditioning system in automobiles

14. Books Recommended:
Text Books:

1) RAC – By C. P. Arora, Tata McGraw Hill

2) RAC – By Arora & Domkundwa, Dhanpat Rai and Sons

Reference Books:

1) Dossat R.J., Principles of refrigeration, John Wiley, S.I. Version (2001).

2) Stoecker W.F., Refrigeration and Air conditioning, McGraw-Hill Book Company, 1989

Reference websites:

1. http://refrigerationandairconditioning.danfoss.com/support-center/apps-and-software/software/#/
2. http://nptel.ac.in/downloads/112105129/
3. http://nptel.ac.in/courses/112107208/

The practice part will have following components

Problem Solving

Sr. No.	Topic	Mode	COs covered
6.	• Outline the tutorial objectives and tutorial work plan • Outline the evaluation and marking scheme • Explaining course outcomes(Cos) • Introductory topics of the subject • Air refrigeration cycle and systems • P-h chart and T-s diagram	• 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
7.	• Simple VAS, practical VAS problems • Air conditioning & psychometry problems	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO2
Minor Test			
8.	• Load calculation • AC system controls, • Quiz	• Tutorial Sheet 3, Doubt clearance • By dividing the batch in two groups, oral quiz	CO3

		will be conducted	
9.	• Self-study topics: Types of refrigerant and their applications, Window air conditioning system, split air conditioning system, air conditioning system in automobiles • 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
4.	Study of a refrigerant compressor	Performance based	3	90 min
5.	Study of a vapor compression refrigeration system	Performance based	3	90 min
6.	Study of an air conditioning test rig	Performance based	3	90 min
7.	Study of an ice plant	Study based	3	90 min
8.	Study of a heat pump	Performance based	3	90 min
9.	Study of Electrolux refrigerator	Performance based	5	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: Power Plant Engineering	**3. Course Code**	**4. L-T-P**	**5. Credits**
	Code: MEL 404	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:

Analysis of steam cycles: Rankine Cycle, Reheat and Regeneration; Thermal Power Plant – Components, operation, combustion mechanisms; Gas turbine and combined cycle power plants; Nuclear power plant - Nuclear reactors: types & their relative merits & limitation; Hydro-electric power plants – Construction, Operation of different components of hydraulic power plant; Environmental aspects of power generation – Emissions, Thermal, Nuclear and Hydro, Power plant Economics;

Practice(T/P): Numerical on economics and steam cycles, and case studies

Practice(T/P): Numerical on economics and steam cycles, and case studies

Software Required: COSMOS, Power Plant Design

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	Understand different types of power plant, and their operations
CO 2	Analyze and solve power power plant cycles
CO 3	Understand and analyze economics of power plants
CO 4	Understand environmental issues in power sectors

11. UNIT WISE DETAILS No. of Units: ___5_____

Unit Number: 1 No. of Lectures: 5 Title: Introduction to power plants

Content Summary: Power plants-Features - Components, Rankine cycle – improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

Unit Number: 2 No. of Lectures: 8 Title: Diesel, Gas Turbine and Combined cycle power plants

Content Summary: Otto, Diesel, Dual & Brayton Cycle – Analysis & Optimization. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

Unit Number: 3 No. of Lectures: 7 Title: Nuclear power plants

Content Summary: Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants

Unit Number: 4 No. of Lectures: 4 Title: Power from renewable energy

Content Summary: Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems

Unit Number: 5 No. of Lectures: 4 Title: Energy, Economic and Environmental issues of Power Plants

Content Summary: Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants

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

Study of government policies regarding energy efficiency, development of hybrid cycles, case studies of power plants for increasing their performance,

13. Books Recommended :
Text Books:

1. Nag P.K. Power Plant Engineering, Tata McGraw – Hill Publishing Company Ltd., 2013
2. El-Wakil M.M. , Power Plant Technology, Tata McGraw – Hill Publishing Company Ltd., 2010

Reference:

1. Black & Veatch, Power Plant Engineering, Springer
2. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, Standard Handbook of Power Plant Engineering, McGraw – Hill, 2012.
3. Godfrey Boyle, Renewable energy, Open University, Oxford University Press

The practice part will have following components

Sr. No.	Activity	Description	Unit covered	Time Required
1.	Discussion	Introduction to the subject and syllabus, prerequisites of the subject	**1**	**45 min**
2.	Discussion	Power plants- Features - Components, Layout of modern power plant and description	**1**	**45 min**
3.	Discussion	Rankine cycle – improvisations, Boilers : working and components	**1**	**45 min**
4.	Practice	Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.	**2**	**45 min**
5.	Discussion and Practice	Previous topic	**2**	**45 min**

		continued		
6.	Discussion and Practice	Otto, Diesel, Dual & Brayton Cycle – Analysis & Optimization	**2**	**45 min**
7.	Evaluation	Previous topic continued	**1,2**	**45 min**
8.	Practice	Previous topic continued with numericals	**3,4**	**45 min**
9.	Practice	Components of Diesel and Gas Turbine power plants	**3,4**	**45 min**
10.	Practice	Previous topic continued	**3,4**	**45 min**
11.	Discussion	Combined Cycle Power Plants description	**3,4**	**45 min**
12.	Practice	Integrated Gasifier based Combined Cycle	**3,4**	**45 min**
13.	Practice and Evaluation	Previous topic continued	**3,4**	**45 min**
14.	Evaluation	Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants	**--**	**45 min**
15.		Introduction of different Nuclear Reactors		**45 min**
16.		CANada Deuterium-Uranium reactor		**45 min**

		(CANDU)		
17.		Breeder, Gas Cooled and Liquid Metal Cooled Reactors		**45 min**
18.		Previous topic continued		**45 min**
19.		Safety measures for Nuclear Power plants		**45 min**
20.		Concluding lecture with numericals if any		**45 min**
21.		Hydro Electric Power Plants – Principle, Typical Layout and associated components		**45 min**
22.		Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems		**45 min**
23.		Previous topic continued		**45 min**
24.		Previous topic continued		**45 min**
25.		Power tariff types, Load distribution parameters, load curve		**45 min**

26.		Comparison of site selection criteria, relative merits & demerits		**45 min**
27.		Capital & Operating Cost of different power plants.		**45 min**
28.		Pollution control technologies for Coal and Nuclear Power Plants and concluding remarks		**45 min**

1.	**Lab Project(To be allotted at the start of the semester)**	**Details of Project:** **1)** As suggested by the course coordinator / Any student idea	Semester

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:	**Mechanical Engineering**		
2. Course Name: Mechanics of solids-II	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL315	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: Thin and thick cylindrical pressure vessels: Stress in thin cylindrical and spherical vessels, Lame's theory for thick cylindrical shells, Compound cylindrical pressure vessels. Buckling in columns: Euler's formula for columns, Rankine's formula and Johnson's parabolic formula, Eccentric loading in columns. Stresses in rotating ring, disc and cylinders. Unsymmetrical bending: Parallel axis theorem for product of inertia, Transformation laws, Principal axes, Stresses and deflection due to unsymmetrical bending, Shear center for symmetrical & unsymmetrical sections. Curved beams: Winkler–Bach theory, Value of h2 for various cross-sections, Stresses in various Curved Members like crane hook, ring etc.

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	Evaluate the value of stresses, strain and deformation produced in the thick and thin Pressure vessels subjected to internal and external pressure.
CO 2	Analyze the buckling load for various types of columns subjected to axial and eccentric axial loading.
CO 3	Calculate the value of stresses in the rotating machine elements.
CO 4	Evaluate the value of stresses and deflection in the beams under unsymmetrical bending conditions; Also, determine the shear centers of various cross sections of the beam.
CO 5	Compute the value of stresses induced in curved beam of various cross sections.

11. UNIT WISE DETAILS No. of Units: 5

Unit Number: 1 No. of Lectures: 7 Title: Stresses in Pressure Vessels

Introduction to thin and thick cylindrical pressure vessels, Stress in thin cylindrical and spherical vessels, Lame's theory for thick cylindrical shells, Compound cylindrical pressure vessels

Unit Number: 2 No. of Lectures: 5 Title: Buckling of Columns

Content Summary: Introduction to columns, Euler's formula for columns, Rankine's formula and Johnson's parabolic formula, Eccentric loading in columns

Unit Number: 3 No. of Lectures: 4 Title: Stresses in Rotating Elements

Content Summary: Stresses in rotating ring, disc and cylinders

Unit Number: 4 No. of Lectures: 6 Title: Unsymmetrical Bending

Content Summary: Introduction to unsymmetrical bending, Parallel axis theorem for product of inertia, Transformation laws, Principal axes, Stresses and deflection due to unsymmetrical bending, Shear center for symmetrical section, equal leg angle section, channel section and unequal I section

Unit Number: 5 No. of Lectures: 6 Title: Curved Beams

Content Summary: Introduction to curved beams, Winkler–Bach theory, Value of h^2 for rectangular, trapezoidal, circular, T section, I-section &, triangular section. Stresses in various curved member like crane hook, ring

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

The students should study the text-books, reference books and digital study material to get in-depth knowledge of the subject and practice the numericals as much as they can. Students need to prepare for Compound cylindrical pressure vessel on their own.

13. Books Recommended :

Text Books:

- Ratan, S.S., "Strength of Materials", 3rd edition, McGraw Hill Education, 2016

Reference Books:

- Gere, J.M., Goodno, B.J., "Mechanics of Materials", 8th edition, Cengage Learning, 2013
- Rajput, R.K., "Strength of Materials", 6th edition, S.Chand Publishing, 2015

Reference Website:

- http://nptel.ac.in/courses/105102090/
- https://www.coursera.org/learn/mechanics-1
- https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-050-solid-mechanics-fall-2004/
- http://nptel.ac.in/courses/112101095/

The practice part will have following components

Sr. No.	Topic	Mode	Cos covered
1.	• Introduction to thin and thick cylindrical pressure vessels, Stress in thin cylindrical and spherical vessels, Lame's theory for thick cylindrical shells, Compound cylindrical pressure vessels	• Explanation of basics of thin and thick pressure vessels, stress induced and strain analysis with the help of video/animated lectures. • Tutorial Sheet 1 and 2 • Practice & Doubt clearance sessions	CO1
2.	• Introduction to columns, Euler's formula for columns, Rankine's formula and Johnson's parabolic formula, Eccentric loading in columns	• Explanation about columns, derivation of Euler's formula and its application with the real-life examples • Tutorial Sheet 3 • Practice & Doubt clearance sessions	CO3
3.	• Stresses in rotating ring, disc and cylinders	• Explanation of stresses developed in rotating machine elements with the help of video/animated lectures and real life examples • Tutorial Sheet 4 • Practice & Doubt clearance sessions • Surprise quiz covering sr. no. 1,2,3	CO 3
Minor Test			
4.	• Introduction to unsymmetrical bending, Parallel axis theorem for product of inertia, Transformation laws, Principal axes, Stresses and deflection due to unsymmetrical bending, Shear center for symmetrical section, equal leg angle section, channel section and unequal I section	• Explanation of concept of unsymmetrical bending, deriving formula for stress and deflection, shear centers with the help of video/animated lectures and real life examples • Tutorial Sheet 5 • Practice & Doubt clearance sessions	CO4
5.	• Introduction to curved beams, Winkler–Bach theory, Value of h^2 for rectangular, trapezoidal, circular, T section, I-section &, triangular section. Stresses in various curved member like crane hook, ring	• Explanation of stresses acting in curved beams with the help of video/animated lectures and real life examples • Tutorial Sheet 6 • Practice & Doubt clearance sessions	CO 5

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:	**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. Modern Manufacturing Process	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL318	3-0-0	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:- Need for unconventional machining method, characteristic feature of modern machining processes that distinguish them from conventional machining process, energy used and source of metal removal from modern manufacturing methods, basic principle of new machining methods, advantages and imitations of non-traditional machining processes, classification of new machining methods. Detailed concepts of various non-conventional machinery such as USM, ECM, AJM, EDM, LBM, EBM, PAM, ECG, Chemical Machining, covering six basic details (1) neat sketch (2) working and principles (3) construction (4) advantages and disadvantages (5)applications and (6) process parameters. Injection molding processes for plastics, engineering applications of plastics, Vacuum Sealed Molding Process, Electron Beam & Plasma Arc Welding, Super finishing Processes, Non Destructive Testing (NDT), Powder Metallurgy (PM)

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

Lectures: 42 hours	**Tutorials: --**	**Practice: 0 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	Understanding the need of unconventional machining with practical applications in real life situations.
CO 2	Identify the application of relevant machining methods in practical life situation.
CO 3	Understand the advancements in casting and welding process with identification of application area.
CO 4	Understand ways to get better surface integrity of the manufactured product.
CO5	Understand the ways to identify irregularity on surface without destruction of the manufactured product for practical application.
CO6	Understand practical application of a PM part in real life and significance of PM.

11. UNIT WISE DETAILS No. of Units: ___7_____

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

Content Summary: Need for unconventional machining method, characteristic feature of MMP, comparison between conventional and unconventional machining process, classification of MMP based upon energy used and mechanism of material removal

Unit Number: 2 No. of Lectures: 3 Title: Ultrasonic Machining and AJM

Content Summary: (1) neat sketch (2) working and principles (3) construction (4) advantages and disadvantages (5)applications and (6) process parameters

Unit Number: 3 No. of Lectures: 5 Title: ECM and EDM

Content Summary: Content Summary: (1) neat sketch (2) working and principles (3) construction (4) advantages and disadvantages (5)applications and (6) process parameters

Unit Number: 4 No. of Lectures: 4 Title: EBM & LBM

Content Summary: (1) neat sketch (2) working and principles (3) construction (4) advantages and disadvantages (5)applications and (6) process parameters

Unit Number: 5 No. of Lectures: 5 Title: PAM & CHM

Content Summary: (1) neat sketch (2) working and principles (3) construction (4) advantages and disadvantages (5)applications and (6) process parameters

Unit Number: 6 No. of Lectures: 4 Title: Plastic Processing and PM

Content Summary: Injection molding, extrusion, blow molding, vacuum sealed molding, EBW, PAW

Unit Number: 7 No. of Lectures: 4 Title: Superfinishing Process, NDT and PM

Content Summary: Electro-deburring, Types of non-destructive techniques, Powder manufacturing, PM Process.

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

Detailed study of Superfinishing process and NDT with case studies.

13. Books Recommended :

b). Text Books:

1) Pandey and Shan, “Modern Machining Process”, McGraw Hills, 2014.

2) JAMcGeough, “Advanced Machining Methods”, Chapman and Halls, UK, 2011.

(c). Reference Books:

1) Paulo Davim.J, “Non Traditional Machining Process”, Springer, 2013.

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

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 the semester)**	Study based project report to be submitted in comprehensive manner	Semester

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Automobile System Engineering	**3. Course Code**	**4. L- T - P**	**5. Credits**
	Code: MEL 319	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: Classification, components and system of automobile. Requirements of automobile body, separate body and frame, unitised body. Layout: Front engine front wheel drive, Front Engine Rear wheel drive, Rear Engine Rear wheel drive, Four wheel drive. General arrangement of power transmission system. Clutch: Principle, requirements and types of clutches. Need for and types of gear boxes, transfer case, transaxles. Drive line, differential and drive axle. Need ,requirement and types of suspension system: springs and shock absorbers. Steering systems: Types and requirements of steering system, steering column, power steering. Wheel alignment and front end geometry. Brakes: Types of brakes and braking systems. Power- brakes , ABS .Types of wheel and tyres.

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	Acquire basic knowledge about the vehicle components, assemblies and systems of an automobile.
CO 2	To know the need, function, requirements, principle and construction operation of various automobile system.
CO 3	To know the various types of each system in automobiles.
CO 4	To know the correlation between the various automotive systems.

11. UNIT WISE DETAILS No. of Units: ___7_____

Unit Number: 1 No. of Lectures: 4 Title: Introduction

Content Summary: Classification, Components, Requirements of Automobile Body; Vehicle Frame,Separate Body & Frame, Unitised Body, Car Body Styles, Types; Front Engine Rear Drive & Front Engine Front Drive Vehicles, Rear Engine Rear Wheel drive, Four Wheel Drive Vehicles

Unit Number: 2 No. of Lectures: 4 Title: Clutches

Content Summary: Requirement of Clutches – Principle of Friction Clutch – Wet Type & Dry Types; Single Plate Clutch, Diaphragm Spring Clutch, Multi plate Clutch, Centrifugal Clutches.

Unit Number: 3 No. of Lectures: 4 Title: Power transmission

Content Summary: Requirements of transmission system; General Arrangement of Power Transmission system; Need of the Gear Box; Different types of Gear Boxes; Sliding Mesh, Constant Mesh, Synchromesh Gear Boxes; Transaxle, Transfer case.

Unit Number: 4 No. of Lectures: 4 Title: Drive Lines, Universal Joint, Differential and Drive Axles

Content Summary: Drive Lines, Universal Joint, Differential and Drive Axles: Types of load coming on Rear Axles. Effect of driving thrust and torque reactions; Hotchkiss Drive, Propeller Shaft, Universal Joints, Slip Joint; Constant Velocity Universal Joints; Principle, Function, Construction & Operation of Differential; Rear Axles.

Unit Number: 5 No. of Lectures: 4 Title: Suspension System

Content Summary: Suspension Systems: Need for Suspension System, Requirements of a suspension system. Types of Suspension; Suspension Spring; Constructional details and characteristics of coil, leaf, torsion springs; Telescopic double acting hydraulic shock absorber, antiroll bar.

Unit Number: 6 No. of Lectures: 4 Title: Steering System

Content Summary: Front Wheel geometry viz. Caster, Camber, King pin Inclination, Toe-in/Toe-out & Wheel alignment; Conditions for true rolling motions of wheels during steering; Different types of Steering Gear Boxes; Power steering – Rack & Pinion Power Steering, Electronics power steering.

Unit Njumber-7 No. Of Lectures 4 Title: Automotive Brakes, Tyres & Wheels

Content Summary: Types of brakes and braking systems. Principle and constructional details of Drum Brakes, Disc Brakes; Brake actuating systems; Mechanical, Hydraulic, Pneumatic Brakes; Power Brakes, ABS.Tyres and Wheels; Types of Tyre & their constructional details.

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

Different case studies different vehicles for automotive systems

13. Books Recommended :
Text Books:

1. Automobile Engineering by Anil Chhikara, Satya Prakashan, New Delhi.

2. Automobile Engineering by Dr. Kirpal Singh, standard Publishers Distributors.

Reference Books:

1.Automotive Mechanics – Crouse / Anglin, TMH

2. Automobile Engineering –TTTI, Pearson India

3. Automobile Engineering - Newton and Steeds.

Reference websites:

www.saeinternational.com

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	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject	CO1
2.	• Quiz	• By dividing the batch in two groups, oral quiz will be conducted	CO2

Minor Test			
3.	• Quiz	• Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO3
4.	• Case studies/real life examples	• 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

1.	**Mini 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: 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**		
Course Name: Emerging Automotive Technologies **2.**	**3. Course Code** **Code:** MEL-409	**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: Future of automotive industry, Industry challenges and concepts for 21st century, crucial issues facing the industry and approaches to meet these challenges. Emerging safety related technologies. Hydrogen fuel - economy, fuel cell technology for vehicles. Power trains for future vehicles. Latest engine technologies features to optimize engine efficiencies (GDI, HCCI, CAMLESS Engine, VCR, VCT, VVT, and DOD). Emerging emission control technologies (DPFT, SCR).Integrated starter generator .Electro mobility: Potentials and Challenges Electric, Hybrid/Plug-in-Hybrid, Fuel cell vehicles, current status future development and prospects. Energy storage devices: Lithium ions battery, Ultra capacitors. X-By- wire technology and its applications in automotive systems. Constantly variable transmission, Duel clutch gear box.

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	Able to state the relevance and viability of Emerging Automotive Technologies on the design and development of new automobiles in the near future.
CO 2	Able to comment on the main issues faced by the automotive industries.
CO 3	Able to give logical and viable solutions for the problems faced by automotive industries.
CO 4	Able to incorporate changes in design keeping in view the emerging technologies.

11. UNIT WISE DETAILS No. of Units: ___7_____

Unit Number: 1 No. of Lectures: 4 Title: The Future of Automobile Industry

Content Summary: Challenges and concepts for the 21st century. Crucial issues facing the industry and approaches to meet these challenges. Emerging safety related technologies.

Unit Number: 2 No. of Lectures: 4 Title: Fuel Cell Technology for Vehicles

Content Summary: What is fuel cell? Current state of the technology, Potential and Challenges. Potential and Challenges of Hydrogen Fuel.

Unit Number: 3 No. of Lectures: 4 Title: Advances in IC Engine Technologies

Content Summary: Features to optimize engine efficiency (GDI, Cam less engine, VCR, VCT, VVT, DOD).Direct Fuel Injection Gasoline engine. Variable valve timing. Methods used to affect variable valve timing- electromagnetic valve, cam less engine actuation. Homogeneously Charged Compression Ignition engine (HCCI).

Unit Number: 4 No. of Lectures: 4 Title: Electrical and Hybrid Vehicles

Content Summary: Potential and Challenges of electrical vehicles- battery electric vehicles, Fuel cell electric vehicles. Types of hybrid systems, Objectives, status, Potential and Challenges of hybrid systems. Plug in hybrid- Potential and Challenges.

Unit Number: 5 No. of Lectures: 4 Title: Integrated Starter Alternator / Energy storage systems.

Content Summary: Start Stop operation, power assist, regenerative braking and Lithium ion batteries. Development of new energy storage systems, deep discharge and rapid charging ultra capacitors.

Unit Number: 6 No. of Lectures: 4 Title: X By Wire technologies and its applications in automobile systems

Content Summary: What is X By Wire? Advantages and impact of X By Wire technology on vehicle design. Potential and Challenges. Throttle by wire, Brake by wire and Steer by wire.

Unit Njumber-7 No. Of Lectures 4 Title: Emission control devices and technologies/ Transmission Systems

Content Summary: Diesel Particulate Filter Technology (DPFT), Selective Catalytic Reduction (SCR) technology.

Constantly Variable Transmission (CVT) – Advantages and limitations. Duel clutch gear box- construction, operation and benefits

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

Different case studies different vehicles for automotive systems

13. Books Recommended :

Text Books:

1) Advanced Vehicle Technologies by Heinz Heisler – SAE International Publications

2) Electric and Hybrid Electric Vehicles by Ronald K Jurgan - SAE International Publications

Reference Books:

1) Automotive Hand Book (Bosch) 12th Edition – Bentaley Publishers

2) Automobile Engineering - Newton and Steeds.

3) Automobile Engineering –Ramakrishna, PHI, India

Reference websites:

www.nptel.com

The practice part will have following components

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	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject	CO1
2.	• Quiz	• By dividing the batch in two groups, oral quiz will be conducted	CO2

Minor Test			
3.	• Quiz	• Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO3
4.	• Case studies/real life examples	• 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

1.	**Mini 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: 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**		
2. Course Name: Modern Power Plants	**3. Course Code**	**4. L-T-P**	**5. Credits**
	MEL 609 TH	2-0-2	3
6. **Type of Course (Check one):**	Programme Core ☐ Programme Elective ☑ Open Elective ☐		
7. Pre-requisite(s), if any	Thermodynamics Energy Conversion		

8. Books Recommended :

1.P.K.Nag, Power Plant Engineering; TMH Publishing Co. Ltd., New Delhi, 2014

2. M. M. Vakil, TMH Publishing Co. Ltd " Power Plant Technology"

3. Black & Veatch, " Power Plant Engineering", Kluver Academic Publishers, Boston.

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

10. Brief Syllabus:

Power Plant Economics - Factors affecting power plant operation; Analysis of steam cycles;Fuels for Power Plants - Coal, Natural Gas, Diesel and Biomass; Steam Generators - Types and operation; Steam power plant - Pulverized Coal and Fluidized Bed Technology; Gas turbine and combined cycle power plants - types and operation; Nuclear power plant - Types and operation, Advantage & limitation, Nuclear reactors: types & their relative merits & limitation; Hydroelectric power plant - Construction and operation of different components of hydraulic power plant; Cogeneration, Environmental aspects of power generation - Emissions from power plants, mitigation of emissions, ecology and environmental effects and nuclear waste disposal.

Pn: Numerical on economics of power plants and steam cycles, 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	Analyze economics of power plants and list factors affecting the power plants
CO 2	Calculate the performance parameters of various power plants

CO 3	Identify elements and their functions of steam, gas, hydro, diesel and nuclear power plants
CO 4	Knowledge of the operation, construction and design of various components of power plants
CO 5	Knowledge and awareness about the environmental pollution and mitigation from power plants

12. UNIT WISE DETAILSNo. of Units: 7

Unit Number: 1 No. of Lectures: 3Title:Power Plant Economics

Content Summary: Site selection and location of steam power plant, Layout of thermal power plant, Load duration curves, Power plant economics.

Unit Number: 2No. of Lectures: 4Title: Analysis of Steam Cycles

Content Summary: Simple and modified Rankine cycle, Effect of operating parameters on Rankine cycle performance, Effect of superheating, Effect of maximum pressure, Effect of exhaust pressure, Reheating and regenerative Rankine cycle, Types of feed water heater, Reheat factor, Binary vapor cycle.

Unit Number: 3No. of Lectures: 6Title: Thermal Power Plant

Content Summary: Coal, Types of coal and their characteristics, Coal analysis, Fuel oil and natural gas, biomass,Combustion equipment for burning coal with a special emphasis to coal feeders & coal mills, Fluidized bed combustion, Mechanical stokers, Pulverized coal firing system, Cyclone furnace, Description of main boiler: Classification and Types of Steam Generators, Fundamentals of Boilers design. Constructional details including steam water circuit of high pressure and high capacity water tube boilers, Economizers, Super-heaters, De-Superheater, Re-heaters, Boiler Circulation Theory: Boiler Drum & its Internals, Boiler Mountings. Feed water treatment. Air Pre-heater: Types and functions, Constructional details, SCAPH, Soot Blower. Draft System: Theory of Natural, Induced, Forced and Balance Draft, Constructional details / Lubricating Oil System for PA Fan, FD Fan, ID Fan etc. Layout.

Unit Number: 4No. of Lectures: 3Title: Gas Turbine and Combined Cycle Power Plant

Content Summary: Closed cycle and open cycle plants, Components of gas turbine plant- compressor, combustion chamber, turbine, Gas turbine materials, Limitations of steam turbine (ST) and gas turbine (GT) power plants, Thermodynamics of multifluid coupled cycles, Combined Brayton and Rankine Cycle and GT-ST plants; Advantages of CC plants, Cogeneration type power plants.

Unit Number: 5No. of Lectures: 4Title: Nuclear Power Plants

Content Summary: Introduction, Location of nuclear power plant, Nuclear power station in India, India's 3-stage programme for nuclear power development, Comparison between nuclear plants and thermal plants,General components of nuclear reactor, General problems of reactor operation, Different types of reactors: Pressurised Water Reactors (PWR), Boiling Water Reactors (BWR), Heavy Water – cooled and Moderated CANDU (Canadian Deuterium Uranium), Gas-cooled Reactors, Breeder Reactors, Reactor Containment Design, , Nuclear Materials: Introduction, Fuels, Cladding and structural materials, coolants, Moderating and reflecting materials, Control rod materials, Shielding materials.

Unit Number: 6No. of Lectures: 4Title: Hydro Power Plants **Content Summary:**Potential of hydropower in India- its development and future prospect, General hydrology-hydrological cycle, precipitation, run-off and its measurement, hydrography, unit hydrograph, flow duration and mass curve, Site investigations. Classification of hydroelectric power plants, Pondage and storage, Operating principles of compoundment and run-off-the-river hydel plants, Storage reservoir plant-pumped storage plant, Parts and operation of different components: Dams, spillways, Canals, penstocks, surge tanks, draft tubes etc; Power – house structure Selection of prime mover, speed and pressure regulation, methods of governing, starting and stopping of water turbines, operation of hydro turbines.
Unit Number: 7 No. of Lectures: 4Title:Environmental Aspects of Power Generation **Content Summary:**Emissions from power plants**,** Electrostatic precipitator: Basic working principle and constructional details of electrostatic precipitator, Corona effect, mapping Mechanism, Ash handling system: Bottom ash, Fly ash, System layout, equipment description, Ash disposal and utilization. Sulphir scrubbers. Nuclear waste & Its disposal: Types of nuclear waste, Effects of nuclear radiation, Radioactive waste disposal system, Gas disposal system.
13. Title of Lab. Manual, if applicable:
14. Brief Description of Self-learning components by students (through books/resource material etc.): **1. Power-point Presentations** **2. LMS**

15. **Details of Pn:**

S.No.	Tutorial Description	Unit Covered
1	Numerical Problems on Power Plant Economics	1
2	Numerical Problems on Power Plant Economics	1
3	Numerical Problems onPower Plant Economics	1
4	Numerical Problems on Analysis of Steam Cycles	2
5	Numerical Problems on Analysis of Steam Cycles	2
6	Numerical Problems on Analysis of Steam Cycles	2
7	Numerical Problems on Analysis of Steam Cycles	3
8	Surprise Quiz	1,2,3
9	Study of Working of Steam Power Plant	3
10	Study of Working of Gas Turbine Power Plant	3
11	Student presentations	

12	Student presentations	
13	Student presentations	
14	Student presentations	

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: 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.):

3. **Power-point Presentations**
4. **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: Energy management	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL 484	2- 1-2	4
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, Environment pollution, Carbon Footprint, global warming and climate change, Ecology, Structure and functioning of natural ecosystems, Natural resources, Agricultural, industrial systems and environment, Energy technologies and environment, 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 correlate basics of energy management, principles of energy management and renewable sources
CO 2	To define & calculate energy efficiency of thermal systems.
CO 3	To define and estimate efficiency of mechanical – electrical utilities.
CO 4	To evaluate energy performance of different systems and learn energy audit concept.

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

Unit Number: 1 **No. of Lectures: 4** **Title: General Aspects of Energy Management**

Content Summary: Energy Scenario: Energy Action Planning, Basics of Energy & its various forms, Financial Management, Definition and Objective of Energy Management, General Principles of Energy Management; Renewable Sources – Water energy, Solar energy, wind energy and biofuels; Geothermal energy; Future energy sources; Hydrogen fuels;

Unit Number: 2 **No. of Lectures: 6** **Title: Energy Efficiency in Thermal Utilities**

Content Summary: Fuels & Combustion, FBC Boilers, Boilers, Steam System, Cogeneration, Furnaces Waste Heat Recovery. Efficiency calculations.

Unit Number: 3 **No. of Lectures: 6** **Title: Efficiency in mechanical – electrical utilities**

Content Summary: Energy Saving in Pumps & Pumping Systems ,Electric Motors, Cooling Tower,Compressed Air System, HVAC & Refrigeration System, Diesel Generating System, -Fan & Blowers, Energy Efficiency Technologies in Electrical Systems

Unit Number: 4 **No. of Lectures: 6** **Title: Energy Performance Assessment for thermal equipment & utility Systems**

Content Summary: Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- it's limitations and constraints. Furnaces- Types and classifications, applications, economics and quality aspects, heat distributions, draft controls, waste heat recovering options, Insulators- Hot and Cold applications, Economic thickness of insulation, Heat saving and application criteria. Steam Utilization Properties, steam distribution and losses, steam trapping.

Unit Number: 5 **No. of Lectures: 8** **Title: Energy Audit**

Content Summary:. Energy Audit – general aspects, Energy Monitoring & Targeting; Material & Energy Balance, Global Environment Concern & Carbon Trading, PAT, ISO 50001, Bureau of Energy Efficiency (BEE),

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

13. Contextual learning component(s)

Study of Energy Audit reports for various Industries and Organizations.

14. Books Recommended:

Text Books:

1) Paul W. O'Callaghan., Energy Management, McGraw-Hill Book Company, 1993.

2) Energy Audit and Management, Volume-I, IECC Press

Reference Books:

1) Mirjana Radovanović (Golusin), Stevan Popov, Sinisa Dodic, Sustainable Energy Management, Academic Press (2013).

Reference websites:

NPTEL online courses

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 scenario- current world • General Principles of Energy Management • Renewable energy resources • 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.	Energy efficiency calculations – thermal systems	• Tutorial Sheet 2, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO2
Minor Test			
3.	Energy efficiency calculations – mechanical systems	• Tutorial Sheet 3, Doubt clearance	CO3

4.	Performance evaluation, Loss analysis	• Tutorial Sheet 4, 5 &6 • 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 energy systems & their performance on campus	Study based	All
2.	Written reports /case studies on energy management in Indian cities.	Study based	All
3.	Energy management/ audit project.	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 (100 Marks) □ Major: **70 Marks** □ Minor: **30 Marks** □ Online Quiz (s): **10 Marks** □ Assignment, Class Tests, presentations, projects: **20 Marks**
Practical Part : 50+20 (Total 70 marks)
Total 200 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		
2. Course Name: Theory of Machines	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL206	3-1-2	5
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: Kinematic Links, Kinematic Pairs, Kinematic Chains, Planar Mechanisms, Degree of Freedom, Inversions of Planar Mechanisms. Kinematics: Displacement, Velocity and Acceleration analysis of planar mechanisms. Dynamics: Static and Dynamic Force Analysis of Planar Mechanisms, Flywheel, Balancing of Rotating and Reciprocating Masses. Classification of Gears, Gear Terminology, Law of Gearing, Velocity ratio, Teeth Profile, Interference in Gears, Minimum Number of Teeth, Undercutting, Gear Forces, Different Types of Gear Trains, Analysis of Epicyclic Gear Train, Types of Cams and Followers, Cam Terminology, Cam Profiles, working of Governors and Gyroscope

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

Lectures: 42	**Tutorials: 14**	**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 explain the classification of the mechanisms, degree of freedom of mechanisms, inversions of the mechanisms, kinematics and dynamics of machines.
CO 2	To analyze the velocity and acceleration of planar mechanisms.
CO 3	To design the equilibrium conditions for mechanisms and balance machines for a given system of forces.
CO 4	To study the gears, gear trains and their applications in engineering.
CO 5	To generate the cam profiles and to study governors and gyroscope.

11. UNIT WISE DETAILS **No. of Units: 6**

Unit Number: 1 **No. of Lectures: 8** **Title:** Mechanisms and Machines

Content Summary: : Introduction: Mechanism and Machine, Types of Constrained Motion, Concepts of Kinematic Link, Kinematic Pair, Classification of Kinematic Pair, Kinematic Chain, Degrees of Freedom, Different type of Mechanisms, Inversion, Machine, Numerical Problems. [CO1]

Unit Number: 2 **No. of Lectures: 8** **Title:** Kinematic Analysis of Mechanisms

Content Summary: Introduction, Velocity Analysis, Relative Velocity Method, Instantaneous Centre Method, Acceleration Analysis, Klein's construction, Coriolis Acceleration, Analytical Method, Numerical Problems. [CO1, CO2]

Unit Number: 3 **No. of Lectures: 8** **Title:** Force Analysis

Content Summary: Static Force Analysis: Static equilibrium, Equilibrium of two, three and four force members, Equilibrium of member with two forces and a torque, Force convention, Free body diagrams, Dynamic Force Analysis: Inertia force analysis, Dynamics of Slider- Crank mechanism, Dynamically equivalent link, Numerical Problems. [CO3]

Unit Number: 4 **No. of Lectures: 8** **Title:** Balancing of Machines

Content Summary: Flywheel, Static Balancing of Rotating Masses, Dynamic Balancing, Two Plane Balancing, Balancing of Reciprocating Masses, Balancing of In-Line Engines, Balancing of V-Engines, Balancing of Radial Engines, Direct and Reverse Crank Method, Numerical Problems. [CO3]

Unit Number: 5 **No. of Lectures: 5** **Title:** Gear Trains

Content Summary: Classification of Gears, Gear Terminology, Law of Gearing, Velocity of sliding, Gear Teeth Profile, Path of Contact, Arc of Contact, Contact Ratio, Interference of Involute Gears, Minimum Number of Teeth, Undercutting, Gear, Forces, Different Types of Gear Trains, Analysis of Epicyclic Gear Train. [CO4]

Unit Number: 6 **No. of Lectures: 5** **Title:** Cam profile, governors and gyroscope

Content Summary: Types of Cams and Followers, Cam Terminology, Cam Profiles, Types of governors, working of Governors, Working of gyroscope

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

Different types of Mechanisms; Klein's construction; Dynamically equivalent link; Balancing of shafts, construction of governors, applications of gyroscope, Lab practical work.

13. Contextual learning component(s)

Lab visit and guest lectures.

14. Books Recommended:

Text Books:

1. Ratan, S.S., "Theory of Machines", McGraw Hill Education, 4th Edition, 2016
2. Ghosh, A., Mallik, A.K., "Theory of Mechanisms and Machines", 3rd edition, Affiliated East-West Press, 2016

Reference Books:

1. Shigley, J.E., Uicker, J. J., "Theory of Machine and Mechanisms", McGraw Hill Education, 3rd Edition, 2016

2. Norton, R. L., "Kinematics and Dynamics of Machinery", McGraw Hill Education, 3rd Edition, 2013

Reference websites:

http://nptel.ac.in/courses/112104121/1

The practice part will have following components

Practice No.	Practical/Tutorial/Activity	Description of Practice	Unit/CO Covered
1	Practical/Tutorial	Practical on study of different types of mechanisms. Tutorial on degree of freedom of planar mechanisms.	1/CO1
2	Case study	Case study of parametric investigation of different mechanisms.	1/CO1
3	Tutorial	Numerical on displacement and velocity analysis of the mechanisms. Quiz on mechanisms.	2/CO1,CO2
4	Tutorial/Quiz	Numerical on acceleration analysis of the mechanisms. Quiz on mechanisms.	2/CO1,CO2
5	Practical	Practical on flywheel	4/CO3
6	Tutorial	Numerical on static force analysis. Quiz on static force analysis.	3/CO3
7	Tutorial/Quiz	Numerical on dynamics force analysis. Quiz on force analysis.	3/CO3
8	Practical	Practical on torque-speed of epicyclic gear train.	4/CO3
9	Tutorial	Numerical on balancing of the rotating systems.	4/CO3
10	Tutorial/Quiz	Numerical on balancing of the reciprocating systems. Quiz on balancing of machines.	4/CO3
11	Practical	Practical on balancing of rotating masses.	4/CO3
12	Case study	Case study on balancing of machines.	4/CO3
13	Presentations	Presentations on recent development in mechanism design.	1 to 4
14	Presentations	Presentations on recent development in mechanism design.	1 to 4
15	Practical	Practical on Cam/Follower mechanism	5

16	Practical	Development of cam profile for particular application	5
17	Practical	Practical on governors	5
18	Practical	Practical of gyroscope	5
19	Tutorial	Development of cam profile	5
20	Tutorial	Numerical on governors	5
Details of Mini Project: One group (4 students) project “design and fabrication of mechanism”.			

Evaluation Scheme:

Total Marks: 200
Theory: 130 Marks (Minors: 30, Major: 70, Online Quiz: 10, Continuous evaluation/Assignments:20)
Practical: 70 Marks (Continuous Evaluation of Lab work:50, Final Viva: 20)

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: E-mobility	**3. Course Code**	**4. L- P**	**5. Credits**
	Code: MEL 475	2 - 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: Need of clean mobility, clean mobility option, propulsion requirements for vehicles, motion and dynamic equations for vehicles; **Hybrid and Electric Vehicles**: HEV architectures; EV architectures; Mechanical systems used in EVs and HEVs; Fundamentals of Regenerative Braking; **Electricals**: Electricals in HEVs and EVS; Electrical machines for EVs and HEVs; DC-DC Converters, Boost and Buck-Boost Converters, Multi Quadrant DC-DC Converters, Voltage Control of DC-AC Inverters Using PWM; **Control Systems** for the HEV and EVs; The fuzzy logic based control system; **Batteries & Charging Technology:** Batteries for EVs; Battery Management System; Fuel cell and supercapacitors, Electric vehicle charger; Electric vehicle charger technology; The EV charging station architecture; EV chargers and portfolio management; EV charging and the grid; Smart grid and EVs

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

Lectures: 28 hours	**Tutorials: 0**	**Practical's: 28 hours**

10. Course Outcomes (COs)

ssible 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 understating of the need of electric mobility and types of electric vehicles
CO 2	Demonstrate a basic understanding of operation and components of EVs
CO 3	Demonstrate a basic understanding of operation and components HEVs
CO 4	Demonstrate a basic understanding of electric motors and controllers
CO 5	Demonstrate a basic understanding of the batteries and charging Technology used EVS

11. UNIT WISE DETAILS No. of Units: 05

Unit Number: 1 Title: Introduction to Electric Mobility
Content Summary: Introduction to Electric Vehicle, Overview of EV Challenges, Pure Electric Vehicle, Hybrid Electric Vehicle, Gridable Hybrid Electric Vehicle, Fuel-Cell Electric Vehicle; Overview of EV Technologies: Motor Drive Technology, Energy Source Technology, Battery Charging Technology, Vehicle-to-Grid Technology
Course Outcomes: CO1
Unit Number: 2 Title: Electric Vehicles
Content Summary: Configurations of EVs, Performance of EVs, Traction Motor, Characteristics, Tractive Effort and Transmission Requirement, Vehicle Performance, Tractive Effort in Normal Driving, Energy Consumption;
Course Outcomes: CO2
Unit Number: 3 Title: Hybrid Vehicles
Content Summary: Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains (Electrical Coupling) Parallel Hybrid Electric Drive Trains (Mechanical Coupling) Parallel Hybrid Drive Train with Torque Coupling, Parallel Hybrid Drive Train with Speed Coupling, Hybrid Drive Trains with Both Torque and Speed Coupling; Fundamentals of Regenerative Braking
Course Outcomes: CO2
Unit Number: 4 Title: Electric motor and drive-controller
Content Summary: Introduction to electric motor, Electric truck motor considerations, Brushless DC motor design for a small car, Brushless motor design for a medium car, Brushless PM motor: design, High frequency motor characteristics, Innovative drive scheme for DC series motors
Course Outcomes: CO3
Unit Number: 5 Title: Batteries & Charging Technology
Content Summary: Batteries for EVs; Battery Management System; Electric vehicle charging technology; The EV charging station architecture; EV chargers and portfolio management; EV charging and the grid; Smart grid and EVs;
Course Outcomes: CO5
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. Contextual Learning

- SAE activities, Industrial visit, expert, lecture

14. Books Recommended:

Text Books:

1. M. Ehsani, Y. Gao, S. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles," CRC Press, 2005.
2. Larminie J., Lowry J., "Electric Vehicle Technology Explained," John Wiley & Sons, 2003
3. Hodkinson R., Fenton J., "Lightweight Electric/Hybrid Vehicle Design", Butterworth-Heinemann, 2001
4. Toll M., "DIY Lithium Batteries: How to Build Your Own Battery Packs," 2017

Reference Books:

1. Thaler A., Watzening D., "Weber, Automotive Battery Technology," Springer, 2014
2. Husain I., Electric and Hybrid Vehicles, Design Fundamentals," CRC Press, 2003

Reference websites:

www.saeinternational.com

Tutorial Content

Sr. No.	Topic	Mode	COs covered
1.	Numerical on basic vehicle calculations	Tutorial sheet	CO1
2.	Numerical on basic vehicle calculations	Tutorial sheet	CO1
3.	Numerical on motor sizing	Tutorial sheet	CO3
Minor			
4.	Numerical on battery sizing	Tutorial sheet	CO5

5.	Numerical on battery sizing	Tutorial sheet	CO5

Practical Content

Sr. No.	Title of the Experiment	Experimental / Self-Study	Unit covered	Time Required
1.	Modelling of EV vehicle	Experimental	4	90 min
2.	Modelling of EV vehicle	Experimental	4	90 min
3.	Modelling of EV vehicle	Experimental	6	90 min
4.	Modelling of EV vehicle	Experimental	4	90 min
5.	Modelling of EV vehicle	Experimental	6	90 min

1.	**Lab Project (As per the course coordinator)**	To be done individually or in groups	Semester

Evaluation Scheme

- **Theory Part (65 Marks)**
  - o Major: 35 Marks (35%)
  - o Minor: 15 Marks (15%)
  - o Assignment, Class Tests, presentations, project etc: 10 Marks (10%)
  - o Online quiz (s): 5 Marks (5%)
- **Practical Part (Total 35 marks)**
  - o Regular practical & report writing:25 Marks (25%)

o End Semester practical tests including Viva-Voce: 10 Marks (10%)	
Total	100
NOTE: In order to pass this course a student must secure 40% marks in minor + major with overall 40% marks in total	

COURSE TEMPLATE

1. Department:	**Department of Mechanical Engineering**		
2. Course Name: Mass Transportation Technologies	**3. Course Code**	**4. L- P**	**5. Credits**
	Code: MEL 474	2 - 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: The current state of transport. Challenges facing the transport sector. The changing nature of society and how transport is adapting. The cost of transportation – vehicle noise, emissions and the effects on public health. The cost of transportation – maintaining infrastructure, energy and climate change; **Electric Traction Technology:**

Traction systems, requirement, different systems; Systems of railway electrification; A.C. and D.C. Systems; Electric and diesel traction systems; **Electric Drives:** features of traction drive, desirable properties of Traction motors; traction motors; Heating and cooling of electrical machines; Size and rating of motors; Choice of drives; Control & Braking: Principles of driving, acceleration, speed control, use of gradient marks, procedure to be followed at neutral sections, correct use of electrical and mechanical brakes. Details of pneumatic and brake equipment. Control and braking; **Mass Transit**: Introduction to mass transit options; Criteria in technology selection; Costs; Design and development factors; Performance; Impacts; The myths of BRT; Defining Bus Rapid Transit, History of BRT, Modern BRT systems, Conventional bus systems; Public transport in developing cities; Barriers to BRT; Benefits of BRT; Vehicle Technology; Intelligent Transportation system (ITS); **Advanced Transportation Technologies**: Magnetic Levitation , Hyperloop

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

Lectures: 28 hours	**Tutorials: 0**	**Practical's: 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 a basic understating of the need, importance and challenges of transportation
CO 2	Demonstrate a basic understanding of operation and components of electric traction technology

CO 3	Demonstrate a basic understanding of operation and components of mass transit
CO 4	Demonstrate a basic understanding of operation and components used in rapid transit
CO 5	Demonstrate a basic understanding of operation and components used in advanced transportation technologies

11. UNIT WISE DETAILS No. of Units: 06

Unit Number: 1 Title: Introduction to Transportation

Content Summary: The current state of transport. Challenges facing the transport sector. The changing nature of society and how transport is adapting. The cost of transportation – vehicle noise, emissions and the effects on public health. The cost of transportation – maintaining infrastructure, energy and climate change.

Course Outcomes: CO1

Unit Number: 2 Electric Traction Technology

Content Summary: Introduction; Traction systems; requirement of an ideal traction system; Different systems of traction; Systems of railway electrification; comparison between A.C. and D.C. Systems; Electric Traction Systems – power supply; AC Locomotive; Diesel electric traction; Overhead equipment.

Course Outcomes: CO2

Unit Number: 3 Title: Electric Drives

Content Summary: Significant features of traction drive; Desirable properties of Traction motors; traction motors; DC series motors, AC Series motors; Heating and cooling of electrical machines; Size and rating of motors; Choice of drives; Wheel-slip and parting. Control & Braking: Principles of driving, acceleration, speed control, use of gradient marks, procedure to be followed at neutral sections, correct use of electrical and mechanical brakes. Details of pneumatic and brake equipment.

Course Outcomes: CO2

Unit Number: 4 Title: Mass Transit

Content Summary: Introduction to mass transit options; Criteria in technology selection; Costs; Design and development factors; Performance; Impacts; The myths of BRT; Defining Bus Rapid Transit, History of BRT, Modern BRT systems, Conventional bus systems; Public transport in developing cities; Barriers to BRT; Benefits of BRT; Vehicle Technology; Intelligent Transportation system (ITS);

Course Outcomes: CO3

Unit Number: 5 Title: Advanced Transportation Technologies

Content Summary: Magnetic Levitation: Introduction: Electromagnetics; Superconducting Superconductivity; Diamagnetism; Flux Pinning; Electrodynamic Levitation; Passive Damping; Active Damping Control; Electromagnet: Introduction: Levitation; Principle; Properties; Performance Requirements; General Configuration; Railway applications, Trans-rapid etc..; Hyperloop: basics of operation and components.

Course Outcomes: CO5

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

Government policies, regulations, testing systems, case studies

15. Contextual Learning

- Industry visit and
- Expert lecture

16. Books Recommended:

Text Books:

1. Vuchic V. R., "Urban Transit Systems and Technology," Wiley, 2007
2. Abad G.,"Power Electronics and Electric Drives for Traction Applications," Wiley, 2007
3. Rajput R.K., "Utilization of Electric Power," Laxmi Publication

Reference Books

4. Han H.S., Kim D. S., "Magnetic Levitation Maglev Technology and Applications
5. Ehsani M., Wanf F. Y., Brosch G. L., "Transportation Technologies for Sustainability," Springer, 2012
6. Steimel A., Electric Traction – Motive Power and Energie Supply – Basics and Pratical Experiences," Oldenbourg Industrieverlag GmbH, 2008

Reference websites:

Tutorial Content

Sr. No.	Topic	Mode	COs covered
6.	Numerical on transportation cost	Tutorial sheet	CO1

	assessment		
7.	Diesel and Electric Locomotives	Assignment	CO2
8.	Numerical on Speed time curves	Tutorial sheet	CO2
9.	Numerical on Speed time curves	Tutorial sheet	CO2
Minor			
10.	Numerical on tractive effort and energy consumption	Tutorial sheet	CO2
11.	Numerical on tractive effort and energy consumption	Tutorial sheet	CO2
12.	Numerical on tractive drives	Tutorial sheet	CO2
13.	Numerical on tractive drives	Tutorial sheet	CO2

Practical Content

Sr. No.	**Title of the Experiment**	**Experimental / Self-Study**	**Unit covered**	**Time Required**
6.	Study of AC Electric Motors	Self-Study	2	90 min
7.	Study of DC Electric Motors	Self-Study	2	90 min
8.	Testing of AC Electric Motors	Experimental	2	90 min
9.	Testing of DC Electric Motors	Experimental	2	90 min

1.	**Lab Project (As per the course coordinator)**	To be done individually or in groups	Semester

Evaluation Scheme

- **Theory Part (65 Marks)**
  - Major: 35 Marks (35%)

o Minor: 15 Marks (15%) o Assignment, Class Tests, presentations, project etc: 10 Marks (10%) o Online quiz (s): 5 Marks (5%)	
• **Practical Part (Total 35 marks)** o Regular practical & report writing:25 Marks (25%) o End Semester practical tests including Viva-Voce: 10 Marks (10%)	
Total	100
NOTE: In order to pass this course a student must secure 40% marks in minor + major with overall 40% marks in total	

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Additive Manufacturing	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL-473	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: History and Advantages of Additive Manufacturing (AM), Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, Direct and Indirect Processes; Prototyping, Manufacturing and Tooling. Layer Manufacturing Processes; Polymerization, Sintering and Melting, Extrusion, Powder-Binder Bonding, Layer Laminate Manufacturing, Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems. Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design of AM. Vat Photopolymerization; Materials, Reaction Rates, Photopolymerization Process Modeling, Scan Patterns, Powder Bed Fusion Processes; Material, Powder Fusion Mechanism, Process Parameters and Modeling, powder Handling, Extrusion Based System; Basic principles, plotting and Path Control, Bio extrusion, Other Systems, Material Jetting; Materials, Material Processing Fundamentals, Material Jetting Machines, Binder Jetting; Materials, Process Variations, BJ Machines, Sheet lamination Processes; Materials, Ultrasonic Additive Manufacturing Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AM based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM. Software Issue for Additive Manufacturing; Introduction, Preparation of CAD Models: The STL file, Problem with STL file, STL file Manipulations, Beyond the STL file, Additional Software to Assist AM. Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities & 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 additive manufacturing and its application.
CO 2	Describe the fundamentals of Additive manufacturing technology.
CO 3	Understand the basics of Additive Manufacturing techniques.

CO 4	Understand the basic concept of design & software programming
CO 5	Describe and apply the concept of additive manufacturing techniques.

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

UNIT-I: Introduction:

History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, Direct and **Indirect Processes**: Prototyping, Manufacturing and Tooling. Layer Manufacturing Processes: Polymerization, Sintering and Melting, Extrusion, Powder-Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing and Bio plotter.

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UNIT-II: Development of Additive Manufacturing Technology:

Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems.

Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design of AM.

UNIT -III: Additive Manufacturing Processes:

Vat Photopolymerization, Materials, Reaction Rates, Photopolymerization Process Modelling, Scan Patterns, **Powder Bed Fusion Processes**; Material, Powder Fusion Mechanism, Process Parameters and Modelling, powder Handling, Extrusion Based System; Basic principles, plotting and Path Control, Bio extrusion, Other Systems, **Material Jetting**; Materials, Material Processing Fundamentals, Material Jetting Machines, **Binder Jetting**; Materials, Process Variations, BJ Machines, **Sheet lamination Processes**; Materials, Ultrasonic Additive Manufacturing, **Directed Energy Deposition Processes**; General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing-Structure-Properties Relationships.

UNIT -IV: Design & Software Issues:

Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AM based New

Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM. **Software Issue for Additive Manufacturing**; Introduction, Preparation of CAD Models: The STL file,

Problem with STL file, STL file Manipulation, Beyond the STL file, Additional Software to Assist AM.

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UNIT-V: Material Design & Quality Aspects:

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities

Applications:

Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.

12. Brief Description of Self-learning component by students (through books/resource material etc.): Additive Manufacturing system and its application. Software for AM.

13. Contextual learning component(s)

3D Printing

14. Books Recommended:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by- Ian Gibson, D Savid W. Rosen, Brent Stucker, Springer.

2. Understanding Additive Manufacturing, by- Andreas Gebhardt, Hanser.

3. Additive Manufacturing, by- Amit Bandyopadhyay, Susmita Bose, CRC Press.

4. Rapid Prototyping: Principles and Applications, by - Chee Kai Chua, Kah Fai Leong, Chu Sing Lim.

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 • AM in industries • Additive Manufacturing Systems and their types • Design of AM	• By providing information about LMS where the tutorial sheets are uploaded • Basic questions related to the introductory part of the subject • Case Study 1, AM in Industries	CO1,CO2
2.	• Additive Manufacturing Process • Quiz	• Case study 2, Doubt clearance • By dividing the batch in two groups, 2 case studies will be discussed	CO3,CO4
Minor Test			
3.	• Design and Software • Quiz	• Case Study 3, Doubt clearance • By dividing the batch in two groups, oral quiz will be conducted	CO4,CO5
4.	• Material Design & Quality aspect • Application in different industries. • 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 using software	Performance based	3 & 4

1	**Case study/ mini project (to be**	Case Study: Impact of Additive Manufacturing in the	

.	**allotted during the semester)**	automotive & Healthcare 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: Robotics and Control	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL 478	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 robotics: Evolution of Robots and Robotics, Progressive advancement in Robots, Robot component , Robot Anatomy, Robot Degree of Freedom, Robot Joints, Robot Co-ordinates, Robot Reference frames, Programing Modes, Robot characteristics, Robot Workspace, Robot Applications. Kinematics of robots-Position analysis: Robot as Mechanism, Conventions, Matrix representation, Homogeneous Transformation, Representation of transformation, Inverse of Transformation, Forward and Inverse Kinematic of Robots, Forward and Inverse kinematics equations: position and orientation, Roll, Pitch ,Yaw Angles, Euler Angles, Articulated Joints, Denavit Hartenberg Representation of forward kinematics, Inverse Kinematic Programming of Robot, Degeneracy and Dexterity , Differential motions and velocities: Differential relationship, Jacobian, Differential versus large scale motions, Differential motions of a frame versus a Robot, Differential motion of a frame about Reference axes, General axis, Frame, Interpretation of the differential change, Differential Change between frames, Simple manipulators: Two /three arm manipulators and their kinematics equations, Work space Homogeneous Transformation: Rotation, Translation, Composition of homogeneous transformations

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	Analyze the human anatomy and understand various stimuli arising in human body.
CO 2	Apply systems theory to complex real world problem objectives in order to obtain models of human anatomy as an engineering system.
CO 3	Design human like robotic structure or small scale (nano robotics) robots for deployment in human body.

CO 4	Develop robotic systems to assist human physiology in order to act as prosthetic devise or surgical robots.

11. UNIT WISE DETAILS **No. of Units: 6**

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

Content Summary: Introduction to robotics: Evolution of Robots and Robotics, Progressive advancement in Robots, Robot component , Robot Anatomy, Robot Degree of Freedom, Robot Joints, Robot Co-ordinates, Robot Reference frames, Programing Modes, Robot characteristics, Robot Workspace, Robot Applications.

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

Content Summary: Kinematics of robots- Position analysis: Robot as Mechanism, Conventions, Matrix representation, Homogeneous Transformation, Representation of transformation, Inverse of Transformation, Forward and Inverse Kinematic of Robots, Forward and Inverse kinematics equations: position and orientation, Roll, Pitch ,Yaw Angles, Euler Angles, Articulated Joints, Denavit Hartenberg Representation of forward kinematics, Inverse Kinematic Programming of Robot, Degeneracy and Dexterity

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

Content Summary: Differential motions and velocities: Differential relationship, Jacobian, Differential versus large scale motions, Differential motions of a frame versus a Robot, Differential motion of a frame about Reference axes, General axis, Frame, Interpretation of the differential change, Differential Change between frames, Calculation of the Jacobian, Inverse Jacobian

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

Content Summary: Dynamic analysis of robot: Lagrangian Mechanics, Effective moment inertia, Dynamic Equation for multiple degree of freedom robots, Static force analysis of Robots, Transformation of forces and moments between coordinates frames

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

Content Summary: Trajectory planning: Path versus Trajectory, Joint space versus Cartesian space Descriptions, Basics of trajectory Planning, Joint space trajectory, Cartesian space Trajectories, Continuous trajectory.

Unit Number: 6 **No. of Lectures: 5**

Content Summary: Control of manipulators: Open and closed loop control, Linear control schemes. Model of manipulator joint, Joint actuator, Partitioned PD control Schemes, PID control schemes, Computed Torque Control, Force control of Robotics Manipulators tasks, Force control strategy, Hybrid Position/ Force control , Impedance

force /Torque control.
12. Brief Description of Self-learning component by students (through books/resource material etc.): Nptel/Mooc platform
13. Contextual learning component(s) Expert talk on advancement of Robots /Industrial visit in automation industry
14. Books Recommended: 1. Niku Saeed B., Introduction to Robotics, John Wiley & Sons b. Mittal R.K. and Nagrath I.J., Robotics and Control, McGraw Hill Education 2. Reference Books 1. Saha S.K., Introduction to Robotics, McGraw Hill Education 3. Craig John J., Introduction to Robotics: Mechanics and Control, Pearson

The practice part will have following components

Problem Solving/case Study

Sr. No.	Topic	Mode	COs covered
1.	To study different types of robots	Tutorial/Mooc/ Online mode	CO1
2.	To calculate DOF using kinematic principle	Tutorial/Mooc/ Online mode	CO2
3.	To calculate transformation of position vector by using matrix method	Tutorial/Mooc/ Online mode	CO3

Practical Content

Sr. No.	Title of the experiment/case study	Performance based/ study based experiments	Unit covered
1.	To study about DOF	Model based/Study	1
2.	To analyse response of PID Controller	Model based/Study	2

3.	To investigate the parameters of DAQ System	Model based/Study	3
4.	To study abut ladder diagram through PLC	Model based/Study	4

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: **70 Marks** □ Minor: **30 Marks** □ Online Quiz (s): **10 Marks** □ Assignment, Class Tests, presentations, projects: **20 Marks**
Practical Part : 50+20 (Total 70 marks)
Total 200 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		
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

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Industrial Automation and Process Control	**3. Course Code Code: MEL 479**	**4. L- T-P** 3-0-0	**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: Production systems Categories of manufacturing systems, manufacturing support systems, automation in production systems, automated manufacturing systems, opportunities for automation and computerization, types of automation, computerized manufacturing support systems, reasons for automating, automation principles and strategies, the USA principle, ten strategies for automation, automation migration strategy ,Automation and control technologies in production system Basic elements of an automated system, advanced automation functions, levels of automation, continuous and discrete control systems, computer process control, common measuring devices used in automation, desirable features for selection of measuring devices ,Material handling system Material handling equipment, design considerations for material handling system, material transport equipment, analysis of material transport systems, storage systems and their performance and location strategies, conventional and automated storage systems, overview of automatic identification and data capture, bar code technology, RFID, other AIDC technologies ,Production and assembly systems Automated production lines- fundamentals, system configurations, work part transfer mechanisms, storage buffers, control of production line, applications Automated assembly systems- fundamentals, system configurations, parts delivery at work stations, applications ,Cellular manufacturing Group technology, part families, parts classification and coding, production flow analysis, Opitz coding system, composite part concept, machine cell design, applications of GT ,Flexible manufacturing systems Introduction to FMS, types of FMS, FMS components, applications and benefits, planning and implementation issues in FMS, quantitative analysis of FMS.

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	Understand the elements of automation and production systems
CO 2	Apply principles of automation for industrial applications

CO 3	Analyze different types of automation.
CO 4	Interpret the different production systems, material handling systems and safety measures.

11. UNIT WISE DETAILS **No. of Units: 6**

Unit Number: 1 **No. of Lectures: 6**

Content Summary: Categories of manufacturing systems, manufacturing support systems, automation in production systems, automated manufacturing systems, opportunities for automation and computerization, types of automation, computerized manufacturing support systems, reasons for automating, automation principles and strategies, the USA principle, ten strategies for automation, automation migration strategy

Unit Number: 2 **No. of Lectures: 5**

Content Summary: Basic elements of an automated system, advanced automation functions, levels of automation, continuous and discrete control systems, computer process control, common measuring devices used in automation, desirable features for selection of measuring devices

Unit Number: 3 **No. of Lectures: 7**

Content Summary: Material handling equipment, design considerations for material handling system, material transport equipment, analysis of material transport systems, storage systems and their performance and location strategies, conventional and automated storage systems, overview of automatic identification and data capture, bar code technology, RFID, other AIDC technologies

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

Content Summary: Automated production lines- fundamentals, system configurations, work part transfer mechanisms, storage buffers, control of production line, applications ,Automated assembly systems- fundamentals, system configurations, parts delivery at work stations, applications

Unit Number: 5 **No. of Lectures: 3**

Content Summary: Group technology, part families, parts classification and coding, production flow analysis, Opitz coding system, composite part concept, machine cell design, applications of GT

Unit Number: 6	**No. of Lectures: 3**
Content Summary: Introduction to FMS, types of FMS, FMS components, applications and benefits, planning and implementation issues in FMS, quantitative analysis of FMS.	
12. Brief Description of Self-learning component by students (through books/resource material etc.):	
13. Contextual learning component(s)	
14. Books Recommended: 1. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Grover, PHI. 2. Theory of Automation of Production Planning and of Tooling: Algorithms for Designing Machine Tools in Automated Industrial Plants, By G. K. Goranskiĭ"	

The practice part will have following components

Case Studies/ Problem Solving

Sr. No.	Topic	Mode	COs covered
1.	To understand and be able to complete the following charts with regard to a specific product, assembly chart, route sheet, operations process chart, from-to chart, and activity relationship chart	Online/Mooc/Expert talk/Tutorial	CO1
2.	To identify equipment requirements for a specific process	Online/Mooc/Expert talk/Tutorial	CO1
3.	To Understand what effect process layout has on the material handling system	Online/Mooc/Expert talk/Tutorial	CO2

4.	To describe and determine the effect of product, process, and schedule	Online/Mooc/Expert talk/Tutorial	CO3
5.	To design parameters on plant layout and materials handling systems design.	Online/Mooc/Expert talk/Tutorial	CO3
6.	To develop and analyse plant layouts using manual and computer aided software methodologies.	Online/Mooc/Expert talk/Tutorial	CO4

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: **25 Marks** □ 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

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Mechatronics System Design	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL 480	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 Mechatronics, Integrated design issues in mechatronics, The mechatronics design process, Mechatronics Key elements, Application in mechatronics. Operator notation and transfer functions, block diagram , manipulations , and simulation, Block diagram modeling direct method and analogy method, electrical system, mechanical translational systems, Mechanical Rotational system, electrical mechanical coupling, fluid system Introduction to sensors and transducers, sensitivity Analysis sensors for motion and position measurement, force , torque and tactile sensors, vibration-acceleration sensors, sensors flow measurement , temperature sensing device, sensor application ,Direct current motors, Permanent magnet stepper motor, fluid power actuation, fluid power design elements, piezoelectric actuators. Number system in Mechatronics, Binary logic , Karnaugh map minimization, Programmable logic controllers, Introducing to signals, systems, and controls, Laplace transform solutions of ordinary differential equations, System representations, linearization of nonlinear systems, Time delays, measured of systems performance, controller design using pole placement method, elements of data acquisition and control system, transducers and signal conditioning, device for data conversing, data conversion process. Application software

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	Formulate specifications for adopting/designing different components of a mechatronic system (mechanical, electrical, sensors, actuators).
CO 2	Construct a mechatronic design using a structured formal approach.
CO 3	Design and implement software for a computer control system with sensor and actuator interfaces.
CO 4	Develop communication interface with a computer control system for tuning.

11. UNIT WISE DETAILS **No. of Units: 6**

Unit Number: 1 **No. of Lectures: 5**

Content Summary: Introduction to Mechatronics, Integrated design issues in mechatronics, The mechatronics design process, Mechatronics Key elements, Application in mechatronics.

Unit Number: 2 **No. of Lectures: 5**

Content Summary: Operator notation and transfer functions, block diagram , manipulations , and simulation, Block diagram modeling direct method and analogy method, electrical system, mechanical translational systems, Mechanical Rotational system, electrical mechanical coupling, fluid system

Unit Number: 3 **No. of Lectures: 5**

Content Summary: Introduction to sensors and transducers, sensitivity Analysis sensors for motion and position measurement, force , torque and tactile sensors, vibration-acceleration sensors, sensors flow measurement , temperature sensing device, sensor application

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

Content Summary: Direct current motors, Permanent magnet stepper motor, fluid power actuation, fluid power design elements, piezoelectric actuators.

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

Content Summary: Number system in mechatronics, Binary logic , Karnaugh map minimization, Programmable logic controllers,

Unit Number: 6 **No. of Lectures: 5**

Content Summary: Introducing to signals, systems, and controls, Laplace transform solutions of ordinary differential equations, System representations, linearization of nonlinear systems, Time delays, measured of systems performance, controller design using pole placement method

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

Nptel/mooc/online course available

13. Contextual learning component(s)

Study of Mechatronics system design for various Industries and Organizations.

14. Books Recommended:

1. Mechatronics System Design, “Devdas Shetty, Richard A. Kolk”, Clengage Learning

2. Mechatronic Systems Design: Methods, Models, Concepts, " Klaus Janschek", Springer

3. Mechatronic Systems, Sensors, and Actuators: Fundamentals and Modeling, " Robert H. Bishop" ,CRC press

4. Mechatronic Futures: Challenges and Solutions for Mechatronic Systems and their designer "Peter Hehenberger, David Bradley", Springer

Reference websites:

NPTEL online courses

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 • Integrated design issues in mechatronics • The mechatronics design process	• 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

Practical Content

1	**Case study/ mini project (to be**	To be done individually or in groups, Discussion and	

.	**allotted during the semester)**	presentation by the students and addressing the problems given in assigned study	

Evaluation Scheme:

Theory Part (100 Marks) □ Major: **45 Marks** □ Minor: **25 Marks** □ 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

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Advanced Robotics	**3. Course Code**	**4. L- T-P**	**5. Credits**
	Code: MEL 481	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: Calculation of the Jacobian, Inverse Jacobian ,Dynamic analysis of robot: Lagrangian Mechanics, Effective moment inertia, Dynamic Equation for multiple degree of freedom robots, Static force analysis of Robots, Transformation of forces and moments between coordinates frames ,Trajectory planning: Path versus Trajectory, Joint space versus Cartesian space Descriptions, Basics of trajectory Planning, Joint space trajectory, Cartesian space Trajectories, Continuous trajectory. Control of manipulators: Open and closed loop control, Linear control schemes. Model of manipulator joint, Joint actuator, Partitioned PD control Schemes, PID control schemes, Computed Torque Control, Force control of Robotics Manipulators tasks, Force control strategy, Hybrid Position/ Force control , Impedance force /Torque control. The DH parameters: As axis placement in 3D space, Transformations in 3D, Euler's Theorem: Chasale's Theorem, Interpolating for general motion in space – finite screws. Jacobian control of planar linkage: Pseudo inverse and Redundant system, Infinitesimal screws, Jacobians for 3D manipulators Kinematics of redundant systems. Parallel manipulators: Some configurations of parallel manipulators, Forward kinematics, Inverse Kinematics, Dynamics. Serial manipulators: Inverse Dynamics of serial manipulators, Forward Dynamics of serial manipulators. Position control of manipulators: Force control of manipulators, Hybrid control strategies, Variable structure control, Impedance control

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	To recognize the design issues in robotics.
CO 2	To locate the phenomenon of redundancy in manipulators.
CO 3	To plan the trajectory of manipulators.
CO 4	To develop position and force control techniques for manipulators.

CO 5	To assess the various characteristics like degeneracy, dexterity, manipulability, manoeuvrability, compliance, etc. of robots.

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

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

Content Summary: The DH parameters: As axis placement in 3D space, Transformations in 3D, Forward kinematics and the inverse kinematics.

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

Content Summary: Euler's Theorem: Chasale's Theorem, Interpolating for general motion in space – finite screws.

Unit Number: 3 **No. of Lectures: 5**

Content Summary: Jacobian control of planar linkage: Pseudo inverse and Redundant system, Infinitesimal screws, Jacobians for 3D manipulators Kinematics of redundant systems.

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

Content Summary: Parallel manipulators: Some configurations of parallel manipulators, Forward kinematics, Inverse Kinematics, Dynamics.

Unit Number: 5 **No. of Lectures: 8**

Content Summary: Serial manipulators: Inverse Dynamics of serial manipulators, Forward Dynamics of serial manipulators. Position control of manipulators: Force control of manipulators, Hybrid control strategies, Variable structure control, Impedance control

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

Nptel/mooc

13. Contextual learning component(s)

Industrial visit/ Expert talk on relevant topic

14. Books Recommended:

1. Nakamura Yoshihiko, Advanced Robotics: Redundancy and Optimization, Addison-Wesley Publishing Company
2. Yoshikawa T., Foundation of Robotics, PHI
3. Saha S.K., Introduction to Robotics, McGraw Hill Education

4. Mittal R.K. and Nagrath I.J., Robotics and Control, McGraw Hill Education on

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 • To make students understand how does a serial robot works • To make students learn how to design a serial robot for a given task • To make students understand the societal impacts of robotic technology	• 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

Practical Content

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: **25 Marks** □ 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

COURSE TEMPLATE

1. Department:	Department of Mechanical Engineering		
2. Course Name: Signal Processing , AI & NN Technique	**3. Course Code** **Code: MEL 486**	**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: Basic Elements of Digital Signal Processing Systems, Classification of Signals, The concept of frequency in Continuous time and Discrete time domain, Discrete-time Signals and Systems, Analysis of Discrete Time, Linear Shift Invariant Systems-Linearity, Causality and Stability criterion, AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation, Searching : Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Expert system. Architecture, knowledge base, inference engine, expert system shell, applications. Fuzzy Logic: Fuzzy sets, membership functions, operation on fuzzy sets; fuzzy control system, Fuzzyfication, knowledge base, inference, defuzzification, application. Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units..Feed-forward Neural Networks: Analysis of pattern Association Networks, Pattern Classification Networks, pattern storage Networks. Pattern Mapping Networks., Linear Auto associative FF Networks, Pattern Storage Networks, Competitive Learning Neural Networks & Complex pattern Recognition, Genetic algorithms: Concepts, encoding and selection methods, genetic operators (crossover and Mutation), applications.

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	Understand the signal processing system
CO 2	Apply signal processing in automation and industrial applications
CO 3	Understand Fuzzy logic, NN and GA Technique

CO 4	Analyze and apply different types of AI techniques in different automation industry

11. UNIT WISE DETAILS **No. of Units: 6**

Unit Number: 1 **No. of Lectures: 6**

Content Summary: Basic Elements of Digital Signal Processing Systems, Classification of Signals, The concept of frequency in Continuous time and Discrete time domain, Discrete-time Signals and Systems, Analysis of Discrete Time, Linear Shift Invariant Systems-Linearity, Causality and Stability criterion,

Unit Number: 2 **No. of Lectures: 5**

Content Summary: AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation, Searching : Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Greedy best first search, A* search Game Playing:

Unit Number: 3 **No. of Lectures: 5**

Content Summary: Expert system. Architecture, knowledge base, inference engine, expert system shell, applications. Fuzzy Logic: Fuzzy sets, membership functions, operation on fuzzy sets; fuzzy control system, Fuzzyfication, knowledge base, inference, defuzzification, application.

Unit Number: 4 **No. of Lectures: 7**

Content Summary: Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units..Feed-forward Neural Networks: Analysis of pattern Association Networks, Pattern Classification Networks, pattern storage Networks. Pattern Mapping Networks., Linear Auto associative FF Networks, Pattern Storage Networks, Competitive Learning Neural Networks & Complex pattern Recognition

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

Content Summary: Genetic algorithms: Concepts, encoding and selection methods, genetic operators (crossover and Mutation), applications.

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

13. Contextual learning component(s)

14. Books Recommended:

1. BaertKosko “Neural network and fuzzy systems”

2. Peterson “Introduction to Artificial Intelligence and expert system (PHI)

3. Michell “Introduction to Genetic Algorithm” (PHI)

4. Vidyasagar M “Theory of learning and generalization” Springer

5. S. Rajasekaran, G.A. VijaylakshmiPai “Neural Networks, Fuzzy Logic and Genetic Algotithm”,

PHI.

The practice part will have following components

Case Studies/ Problem Solving

Sr. No.	Topic	Mode	COs covered
1.	To design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs.	Online/Mooc/Expert talk/Tutorial	CO1, CO2
2.	To use current AI techniques, skills, and tools necessary for computing practice	Online/Mooc/Expert talk/ Tutorial	CO3
3.	To study predictive analysis using ANN technique	Online/Mooc/Expert talk/ Tutorial	CO4

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: **25 Marks** □ 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