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COURSE COMPONENTS OF ACADEMIC PROGRAMME

UNDERGRADUATE PROGRAMME

B.Tech (Mechanical Engineering)

Batch 2018-22

Minimum Duration: 8 Semesters (4 years)

Maximum Duration: 12 Semesters (6 years)

Total number of credits: 189 credits

Course Components			Credits
1.	**Compulsory courses**		
	i.	Foundation course	45
	ii.	Core course	106
2.	**Elective courses**		
	i.	Departmental electives	10
3.	**Discipline-Centric Additional Courses**		
	i.	Project	5
	ii.	Career Skill	4
4.	**General course**		
	i.	Disaster Management	1
	ii.	Seminar & General Proficiency	8
	iii.	Internship	11

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SEMESTER III

S.No	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt./ LR/Att	ESE	Total
	Theory									
1.	TMA303	Engineering Mathematics III	3	0	0	3	25	25	50	100
2.	TME 302	Material Science and Metallurgy	3	0	0	3	25	25	50	100
3.	TME304	Basic Thermodynamics	3	1	0	4	25	25	50	100
4.	TME305	Manufacturing Processes I	3	1	0	4	25	25	50	100
5.	TME306	Engineering Mechanics	3	1	0	4	25	25	50	100
	Labs									
6.	PME 311	Computer Aided Machine Drawing	0	0	4	2	25	25	50	100
7.	PME 312	Metallography & Material Testing Laboratory	0	0	3	1	25	25	50	100
8.	PME 313	Foundry & Forging Lab	0	0	3	1	25	25	50	100
9.	XCS 301	Career Skills-I	2	0	0	1	25	25	50	100
10.	GP301	Seminar & General Proficiency	-	-	-	1	-	-	100	100
11.		Internship I	To be held at the end of III semester							
Total			17	3	10	24	225	225	550	1000

Internship will be of 2 to 4 weeks before the start of next semester. Evaluation will be done in the next semester.

L : Lecture, T : Tutorials, P : Practicals MT : Midterm Examinations

Att. : Attendance Asmt. : Teachers Assessment as Assignments, Seminar,

LR : Lab Record ESE : End Semester Examination

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SEMESTER-IV

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt. / LR/Att	ESE	Total
	Theory									
1.	TME403	Manufacturing Processes II	3	1	0	4	25	25	50	100
2.	TME404	Mechanical Measurements & Metrology	3	0	0	3	25	25	50	100
3.	TME405	Kinematics of Machines	3	1	0	4	25	25	50	100
4.	TME406	Strength of Materials	3	1	0	4	25	25	50	100
5.	TME407	Fluid Mechanics	3	1	0	4	25	25	50	100
	Labs									
6.	PME411	Machine Shop	0	0	3	1	25	25	50	100
7.	PME413	Measurements & Metrology Lab	0	0	3	1	25	25	50	100
8.	PME417	Fluid Mechanics Lab	0	0	3	1	25	25	50	100
9.	XCS401	Career Skills-II	2	0	0	1	25	25	50	100
10.	GP401	Seminar & General Proficiency	-	-	-	1	-	-	100	100
11.	MEI 401	Internship I*	-	-	-	3	-	-	100	100
12		Internship II	To be held at the end of IV semester							
Total			17	4	9	27	225	225	650	1100

***Internship After III Semester**

Internship will be of 2 to 4 weeks before the start of next semester. Evaluation will be done in the next semester.

L : Lecture, T : Tutorials, P : Practicals MT : Midterm Examinations

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SEMESTER-V

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt. / LR/Att	ESE	Total
	Theory									
1.	TME 501	Heat & Mass Transfer	3	1	0	4	25	25	50	100
2.	TME 502	Design of Machine Elements I	3	1	0	3	25	25	50	100
3.	TME503	Dynamics of Machines	3	1	0	4	25	25	50	100
4.	TME506	Fluid Machinery	3	1	0	4	25	25	50	100
5.	TME507	Industrial Engineering	3	0	0	3	25	25	50	100
	Labs									
6.	PME511	HMT Lab	0	0	3	1	25	25	50	100
7.	PME512	DOM Lab	0	0	3	1	25	25	50	100
8.	PME516	Fluid Machinery Lab	0	0	3	1	25	25	50	100
9.	XCS501	Career Skills-III	2	0	-	1	25	25	50	100
10.	GP501	Seminar & General Proficiency	-	-	-	1	-	-	100	100
11.	MEI 501	Internship II*	-	-	-	4	-	-	100	100
Total			17	4	9	27	225	225	650	1100

***Internship After IV Semester**

L : Lecture, T : Tutorials, P : Practicals MT : Midterm Examinations

Att. : Attendance Asmt. : Teachers Assessment as Assignments, Seminar,

LR : Lab Record ESE : End Semester Examination

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SEMESTER-VI

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt./ LR/Att	ESE	Total
	Theory									
1.	TME601	Refrigeration & Air conditioning	3	1	0	4	25	25	50	100
2.	TME602	Design of machine elements II	3	1	0	4	25	25	50	100
3.	TME603	I.C. Engines	3	1	0	4	25	25	50	100
4.	TME606	CAD/CAM	3	0	0	3	25	25	50	100
5.		Elective I	3	1	0	4	25	25	50	100
	Labs									
6.	PME611	Refrigeration & Air Conditioning Lab.	0	0	3	1	25	25	50	100
7.	PME614	Modeling and analysis lab(CFD + FEM)	0	0	3	1	25	25	50	100
8.	PME616	Automation & CNC Lab.	0	0	3	1	25	25	50	100
9.	XCS601	Career Skills-IV	2	0	0	1	25	25	50	100
10.	GP601	General Proficiency	-	-	-	1	-	-	100	100
11.		Industrial Internship	To be held at the end of VI semester							
Total			17	4	9	24	225	225	550	1000

Elective I

Code	Elective name
TME 614	Finite Element Method
TME 615	Computational Fluid Dynamics
TME 616	Numerical Methods Using MATLAB

Industrial Internship will be of 4 to 6 weeks before the start of next semester. Evaluation will be done in the next semester.

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SEMESTER-VII

S NO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt. / LR/Att	ESE	Total
	Theory									
1.	TME701	Mechanical Vibration	3	1	0	4	25	25	50	100
2.	TME704	Operation research & optimization technique	3	1	0	4	25	25	50	100
3.	TME706	Power plant Engineering	3	1	0	4	25	25	50	100
4.	TME707	Automobile Engineering	3	0	0	3	25	25	50	100
5		Elective-II	3	0	0	3	25	25	50	100
6	UCE701	Disaster Management	1	0	0	1	25	25	50	100
	Labs									
7.	PME717	Automobile Engineering Lab	0	0	3	1	25	25	50	100
8.	MEP701	Project work Phase I	-	-	-	1	--	--	100	100
9.	GP701	General Proficiency	-	-	-	1	-	-	100	100
10.	MEI 701	Industrial Internship*	-	-	-	4	-	-	100	100
Total			16	3	3	26	175	175	650	1000

Electives-II

Code	Elective name
TME714	Total Quality Management
TME715	Quality Control
TME716	Computer Integrated Manufacturing

***Industrial Internship after VI Semester**

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Att. : Attendance Asmt. : Teachers Assessment as Assignments, Seminar,

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SEMESTER VIII

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt./ LR/ Att	ESE	Total
	Theory									
1.		**Elective-III**	3	-	-	3	25	25	50	100
2.	MEP801	Project work Phase II	-	-	-	4	-	100	150	250
3.	OLC801	Online Course	-	-	-	6	-	-	100	100
4.	GP801	General Proficiency	-	-	-	1	-	-	100	100
Total			3	-	-	14	25	125	400	550

Elective III

Code	Elective name
TME812	Non-Conventional Energy Resources
TME814	Advanced Welding Technology
TME815	Tribology

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 302**
2. Course Title: **MATERIAL SCIENCE AND METALLURGY**

3. Contact Hours: **L: 3** **T: 0** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 3 **7.** Semester**: III** **8.** Subject Area**: CC**

9.Pre-requisite**:** **Nil**

10. Course Outcome:

Course Outcome 1: Understand the structure of crystalline solids and importance of crystal defects in the properties of engineering materials.

Course Outcome 2: Describe the different mechanical properties by understanding the stress strain curve and its application in engineering materials.

Course Outcome 3: Analyze the behavior of the engineering materials for different modes of fracture and effect of fatigue and creep.

Course Outcome 4: Understand the different phase diagrams and their importance in field of material science.

Course Outcome 5: Analyze the different heat treatment processes in the formation of different types of steels.

Course Outcome 6: Discuss the properties, processing and applications of different engineering materials.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	Structure of crystalline solids: Miller indices, space lattice & concept of unit cell(cubic, HCP structure) including bravais lattices, stacking in cubic & HCP. Calculation of radius, coordination no. & A.P.F. for different cubic structures. Calculations on density. Crystal Imperfections – point, line & surface defects. Diffusion & fick's law of diffusion.	**08**
2.	Elastic deformation & plastic deformation (Slip & twinning). Interpretation of tensile stress-strain curve & mechanical properties, true stress & strain. Fracture & its types, stages in cup & cone fracture. Fatigue:Crack initiation & propagation, fatigue test & S-N curve. Factors affecting fatigue life & protection methods. Creep: Creep test & creep curve. Creep mechanism & creep resistant materials.	**08**
3.	Phase Diagrams: Basic terms, Gibb's phase rule, types of solid solution & rules for governing it. Unary(Fe) phase diagram, binary phase diagram(with partial & complete solid – liquid solubility, Ag – Pt system), lever rule & its application. Iron – carbon equilibrium diagram (Phases, invariant reactions, critical temperatures, microstructures of slowly cooled alloys), TTT diagram, CCT diagram.	**09**
4.	Methods for manufacturing the steel: Heat treatment & its importance. Annealing & its types, normalizing, hardening, tempering (martempering & austempering). Jomint end – quench test. Surface hardening like case hardening, carburizing, Cyaniding, Nitriding, Induction hardening. Corrosion & methods employed to prevent corrosion.	**07**
5.	Engineering Materials: properties, composition & applications of low, medium & high carbon steels. Steel designation(AISI & SAE).Types, applications and mechanical behavior of ceramics , polymers Introduction to Nano materials, Properties and behavior of nano materials.	**08**
	Total	**40**

12. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	aterial science & Engg. By William D. Callister, Wiley india pvt. Ltd.
2.	Material & Metallurgy by O.P. Khanna,Dhanpat Rai publications
3.	Foundation of material Science & engg. By Smith, Mc Graw HILL

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 304** (Revised in 2019)
2. Course Title: **BASIC THERMODYNAMICS**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **Nil**

10. Course Outcome:

Course Outcome 1: Understand the basic terminology, definitions and fundamental concepts of thermodynamics and evaluate the properties of pure substances.

Course Outcome 2: Understand and apply the first law of thermodynamics to engineering problems.

Course Outcome 3: Understand the basic concepts of second law, grades of energy, and second limitations on energy conversion

Course Outcome 4: Understand and evaluate the concepts of entropy, availability and irreversibility

Course Outcome 5: Understand and analyze the behavior of gases and gas mixtures and thermodynamic relations.

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**UNIT 1: Introduction and Properties of Pure Substances** Thermodynamics Introduction: Definition and Scope; Classical and Statistical Thermodynamics; System & Control Volume; Properties of a System; Thermodynamic State and Equilibrium; State Postulate; Processes and Cycles; Quasi-Equilibrium Process; Temperature and the Zeroth Law of Thermodynamics; Forms of Energy and Physical Insights in it; Energy Transfer by Heat and Work; Path and Point Functions; Exact and Inexact Differentials;	12

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	Forms of Work (Electrical, Shaft and Boundary Work); First Law of Thermodynamics for a Closed System. Pure Substances; Phase Change of Pure Substances - Compressed Liquid Saturated Liquid, Saturated Vapor, Superheated Vapor, Saturation Temperature and Pressure, Latent Heat; T-V, P-V and P-T Diagrams; Triple Point and Critical Point; Property Tables; Reference State and Values in Property Tables; Saturated Liquid-Vapor Mixture – Quality or Dryness Fraction; Ideal Gas Equation of State; Universal Gas Constant and Gas Constant; Compressibility Factor and Chart; Numerical Related to Properties of Pure Substances	
2.	**UNIT 2: Energy Analysis of Closed Systems and Control Volume** Moving Boundary Work in Various Situations; Polytropic Process; Specific Heats; Internal Energy, Enthalpy and Specific Heat of Ideal Gases; Internal Energy, Enthalpy and Specific Heat of Liquids and Gases; Numerical on Energy Analysis of Closed Systems Steady Flow Process; Flow Work; Steady Flow Energy Equation; First Law Application to Steady Flow Devices – Nozzles and Diffusers, Turbines and Compressors; Throttling Valves, Mixing Chambers; Heat Exchangers; Analysis of Unsteady Flow Processes Such as Charging and Discharging of a tank.	**08**
3.	**UNIT 3: The Second Law of Thermodynamics** Introduction to the Second Law; Thermal Energy Reservoirs; Heat Engines, Refrigerators and Heat Pumps; Kelvin -Planck statement & Clausius statement; Equivalence of Two Statements; PMM1 and 2; Reversible and Irreversible Processes; Carnot and Reversed Carnot Cycles; First and Second Carnot Principle; Thermodynamic Temperature Scale; Quality of Energy; Efficiency and COP of Reversible Heat Engine, Refrigerator and Heat Pump.	**07**
4.	**UNIT 4: Entropy and Availability** Clausius Inequality; Entropy; Increase of Entropy Principle; Entropy Change of Pure Substances; Isentropic Processes; Property Diagrams Involving Entropy: T-s, h-s diagrams; Tds Relations; Entropy Change of Liquids and Solids; Entropy Change of Ideal Gases; Isentropic Processes of Ideal Gases; Reversible Steady Flow Work; Isentropic Efficiency of Turbines, Compressors, Pumps and	**07**

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	Nozzles; Entropy Balance for Control Volume; Measurement of Dryness Fraction. Introduction to gas and vapor power cycles. Exergy or Available Energy; Reversible Work and Irreversibility: Exergy of a Closed System; Exergy of a Flow Stream, Second Law Efficiency .	
5.	**UNIT 5: Thermodynamic Property Relations** Real and Ideal Gases: Vander Waal's Equation; Ideal Gas Mixtures: Dalton's Law of Additive Pressure, Amagat's Law of Additive Volume bbs and Helmholtz Function; Maxwell Relations; Clapeyron Equation; General relations for Change in Internal Energy, Enthalpy, Entropy, C_p and C_v; Joule-Thomson coefficient.	**06**
	Total	**40**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	"**Thermodynamics an engineering approach**" , by Yunus A. Cenegal and Michael A. Boles. Tata McGraw hill Pub.
2.	"**FUNDAMENTALS OF ENGINEERING THERMODYNAMICS**," by Moran, Shapiro, Boettner and Bailey
3.	"**Basic and Applied Thermodynamics**" by P .K. Nag, Tata McGraw Hill.
3.	**"Thermal Engineering"** by Mahesh M. Rathore Tata McGraw-Hill Education.
4.	**Fundamentals of Thermodynamics** by Sonntag, Borgnakke Van Wylen.

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 305**
2. Course Title: **MANUFACTURING PROCESSES – I** (Revised in 2019)
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **Nil**

10. Course Outcome:

Course Outcome 1: Discuss the basics principles, defects and procedure of metal casting and its advantages and applications.

Course Outcome 2: Understand the basics principles, defects, types of forging process, calculation of force required, process variables, process defects and numerical problems.

Course Outcome 3: Understand, classify the forming processes like rolling and sheet metal forming, machine tools used, calculation of force required, process variables, process defects and numerical problems.

Course Outcome 4: Understand, classify the extrusion processes, extrusion of plastics, welding of plastics, machine tool used, process variables, process defects and evaluate jigs and fixtures, its types and applications, locating and clamping devices and drilling bushes in jigs and fixtures.

Course Outcome 5: Understand the fundamentals and developments methods of metal powder and their advantages, limitations and applications.

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Course Outcome 6: Develop the knowledge and skills in the manufacturing processes considering the economic and technological considerations in manufacturing.

11.Details of Course:

nit No.	Contents	Contact Hours
1.	Introduction to manufacturing processes and Casting (Foundry): Importance of manufacturing. Economic & technological considerations in manufacturing. Survey of manufacturing processes. Introduction of different manufacturing processes. Elastic & plastic deformation, yield criteria. Hot working vs cold working. Lubrication in forming processes, Casting (Foundry):Basic principles and survey of Casting processes, Types of patterns and allowances, Types & properties of molding Sand, Designing of Gating system , Risers, Runners, re. Solidification of Castings, Types of casting process, Defects in Casting, their causes& remedies	**08**
2.	rging: Classification of forging processes. Forging machines & equipment. Types of forging. Methods, Hand, Power, Drop Forging. Analysis (equilibrium equation method) of forging process with sliding friction sticking friction and mixed condition for slab, concepts of friction hill and factors affecting it, Die-design parameters, Material flow lines in forging, Forging defects, Residual stresses in forging.	**08**
3.	lling: Classification of rolling processes, types of rolling mills, expression for rolling load, Roll separating force. Frictional losses in bearing etc., power required in rolling, Effects of front & back tensions, friction, friction hill, Maximum possible reduction, Defects in rolled products. Rolling variables Sheet Metal working: Presses and their classification, Die & punch assembly and press work methods and processes. Cutting/Punching mechanism, blanking vs. Piercing, Compound vs. Progressive die. Flat-face vs. Inclined-face punch and defects of drawn products, stretch forming. Roll bending & contouring.	**08**
4.	Extrusion: Types of extrusion processes, extrusion equipment & dies, deformation, lubrication &defects in extrusion. Extrusion dies, Extrusion of seamless tubes. Extrusion variables. Plastics: Extrusion of Plastics, Injection molding, welding of plastics and applications. Jigs &Fixtures: Introduction to Jigs & Fixtures, Locating and clamping devices and principles of location, different types of Jigs and Fixtures, applications of Jigs & Fixtures. Drilling Bushes, their types and applications.	**08**
5.	Powder metallurgy: Basic steps in Powder metallurgy brief description of methods of production of metal powders, conditioning and blending powders, compaction and sintering application of powder metallurgy components, advantages and limitations.	**08**
	Total	**40**

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12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Mechanical metallurgy (SI units), by G.E. Dieter, Mc Graw Hill pub.
2.	Manufacturing Engineering and Technology by SeropeKalpakjian and Stevan
3.	Manufacturing Science,hyAmitabha Ghosh & A.K. Malik - East -Westpress 2001
4.	Principles of Industrial metal working process - G.W. Rowe, CBSpub. 2002

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 306** (Revised 2019)
2. Course Title: **ENGINEERING MECHANICS**(Revised in 2019)
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: III** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Nil**

10. Course Outcome:

Course Outcome 1: Determine the components of a force in rectangular or nonrectangular coordinates, resultant of a system of forces.

Course Outcome 2: Draw complete and correct free-body diagrams and write the appropriate equilibrium equations from the free-body diagram.

Course Outcome 3: Locate the centroid of an area and calculate the second moment of an area, calculate the principal second moments of an area

Course Outcome 4:. Determine the support reactions and forces in trusses and in general frame structures.

Course Outcome 5: Analyze systems that include frictional forces.

Course Outcome 6: Working and analysis of the simple machines.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	Introduction to Engineering mechanics: Force and its characteristics, types of forces, Classification of force systems;, Principle of superposition of forces, Principle of transmissibility of forces; Moment of a force, couple, moment of a couple, characteristics of couple, Equivalent force - couple system; Resolution of forces, composition of forces; Numerical problems on moment of forces and couples, on equivalent force - couple system.	08
2.	Composition of forces - Definition of Resultant; Composition of coplanar - concurrent force system, Numerical problems on composition of coplanar concurrent force systems. Composition of coplanar - non-concurrent force system. Equilibrium of forces - Definition of Equilibrant; Conditions of static equilibrium for different force systems, Lami's theorem; Numerical problems on equilibrium of coplanar – concurrent and non concurrent force systems.	10
3.	Centroid of plane figures; Locating the centroid of triangle, semicircle, quadrant of a circle and sector of a circle using method of integration, Centroid of simple built up sections; Numerical problems. Moment of inertia of an area, polar moment of inertia, Radius of gyration,Perpendicular axis theorem and Parallel axis theorem; Moment of Inertia of rectangular, circular and triangular areas from method of integration; Moment of inertia of composite areas; Numerical problems.	12
4.	Trusses- Introduction, simple force, determination of forces in simple truss members, method of joint and method of sections. Friction - Types of friction, Laws of static friction, Limiting friction, Angle of friction, angle of repose; Impending motion on horizontal and inclined planes; Wedge friction; Ladder friction; Numerical problems.	10
5.	SIMPLE MACHINES- Definitions, , Law of Machine , Variation of Mechanical Advantage , Variation of Efficiency , Reversibility of a Machine, Lever Arm , Pulleys	06

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	,Wheel and Axle , Wheel and Differential Axle , Weston Differential Pulley , Inclined Plane , Screw Jack, Differential Screw Jack	
	Total	**46**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Engineering Mechanics by S.S. Bhavikatti, New Age International Publisher, New Delhi
2.	Engineering Mechanics by K L Kumar, TATA McGraw-Hill Book Company, New Delhi
3.	Engineering Mechanics by S.Timoshenko, D.H.Young, and J.V.Rao TATA McGraw-Hill Book Company, New Delhi

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 311**
2. Course Title: **COMPUTER AIDED MACHINE DRAWING**(Revised in 2019)
3. Contact Hours: **L: 0** **T: 0** **P: 4**
4. Examination Duration (Hrs.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 2 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **Engineering Drawing**

10. Course Outcome:

Course Outcome 1: Able to construct two dimensional and three dimensional drawings in the Auto cad and Creo environments.

Course Outcome 2: Able to understand and draw sections of solids and to find the true shape of the sections, orthographic projections of machine parts and also understand the types of thread forms and their significance.

Course Outcome 3: To understand and draw the types of fasteners, types of joints, keys and types of couplings.

Course Outcome 4: Draw the part drawings after visualizing the given orthographic views and assemble the same to form the final assembly.

11. Details of Course:

Unit No.	Contents	Contact Hours
	PART A	
1.	**Orthographic views:** Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.	**08**

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2.	**Thread forms and Fasteners:** Thread terminology, ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Hexagonal headed bolt and nut and square headed bolt and nut.	**08**
3.	**Keys and Joints:** Parallel key, Taper key, Feather key, Gib's head key and Woodruff key Riveted Joints: single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.	**09**
4.	**Couplings:** Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)	**09**
PART: B **(Assembly Drawings (Part drawings are given))**		
5	**Screw jack (Bottle type)**	**06**
6	**Plummer block (Pedestal Bearing)**	**06**
7	**Machine vice**	**12**
8	**Tailstock of lathe**	**12**
	Total	**70**

Software Used:

1. AutoCAD 2016 for Part A
2. Pro-E (Creo-2.0) for Part B

12. Suggested Books:

S. No.	Name of Authors /Books /Publisher
1.	'Machine Drawing', N.D. Bhat & V.M.Panchal
2.	'Machine Drawing' , N. Siddeshwar, P. Kanniah, V.V.S. Sastri,published by Tata Mc GrawHill,2006
3.	'A Text Book of Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007
4.	'Machine Drawing with Auto CAD'. Goutam Pohit & Goutham Ghosh, IST Indian print Pearson Education, 2005
5.	'Auto CAD 2006, for engineers and designers'. Sham Tickoo. Dream tech

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 312**
2. Course Title: **METALLOGRAPHY AND MATERIAL TESTING LAB**(Revised in 2019)

3. Contact Hours: **L: 0** **T: 0** **P: 3**

4. Examination Duration (Hrs.): **Mid** 3 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **PSM** 25

6. Credits**:** 1 **7.** Semester**: III** **8.** Subject Area**: CC**

9. Pre-requisite**:** **Material Science, Mechanics of Material**

10. Course Outcome:

Course Outcome 1: Understand the Mechanical properties like toughness by performing impact and charpy test and performing torsion testing of a rod.

Course Outcome 2: Analyzing mechanical properties by performing tensile test, compression test and bending test..

Course Outcome 3: Determine the hardness by performing hardness test on Rockwell and brinnel testing machine and comparing hardness of different steels..

Course Outcome 4: Performing test on spring testing machine and analyze different heat treatment processes by preparing the specimen for microstructure examination.

11. List of Experiments

Note: Students are required to perform minimum 14 experiments out of these 16 experiments.

1. To conduct tensile test on a mild steel specimen with help of the universal testing machine and determine the ultimate tensile strength, percentage elongation and reduction in area.

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2. To conduct compression test on a mild steel specimen with help of the universal testing machine and determine the ultimate compression strength, percentage compression and increase in area.
3. To find the values of bending stresses and young's modulus of the material of a beam (say a wooden or steel) simply supported at the ends and carrying a concentrated load at the centre.
4. To conduct the Charpy Impact Test on the impact testing machine and to find the impact strength.
5. To conduct the Izod Impact Test on the impact testing machine and to find the impact strength.
6. To perform Torsion Testing of a rod on torsion testing machine.
7. To calculate the stiffness of spring using spring testing machine.
8. To determine the hardness of the given specimen using Rockwell Hardness Testing Machine.
9. To determine the hardness of the specimen using Brinell Hardness Testing Machine.
10. To compare the hardness of the given specimen (Aluminum, Mild steel, High carbon steel) using Rockwell testing machine
11. Heat treatment experiment such as annealing, normalizing and Quenching of carbon steel.
12. Comparative study of microstructure of different specimen (mild steel high speed steel, high carbon steel, aluminum, copper, brass)
13. To prepare the M.S. specimen for micro structural examination using cutting, grinding, polishing and etching.
14. To prepare the C.I. specimen for micro structural examination using cutting, grinding, polishing and etching.
15. To prepare the Aluminium specimen for micro structural examination using cutting, grinding, polishing and etching.
16. To make a plastic mould for small metallic specimen by moulding press.

INNOVATIVE EXPERIMENT

17. To prepare the mild steel specimen for surface coating & study of microstructure.
18. To study the defect of raw material & welded specimen using Dye penetration testing.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 313**
2. Course Title: **FOUNDRY AND FORGING LAB**(Revised in 2019)
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 1 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **Manufacturing Processes**

10. Course Outcome:

Course Outcome 1: To understand and analyze various properties of sand and their effect.

Course Outcome 2: To understand the moulds and mould developing techniques.

Course Outcome 3: To understand design & study the applications of different casting techniques and their defects.

Course Outcome 4: To understand and develop Machine Element by Forging technique.

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11. List of Experiments:

Note: Students are required to perform minimum 14 experiments out of these 16 experiments.

1. To determine moisture content in the sand sample(electric oven).
2. To determine moisture content in a green sand
3. Preparation of green sand
4. To determine moisture content in a given sand(Rapid moisture teller).
5. To study different types of sands used in making moulds.
6. To determine the grain fineness no. of a given sand sample(sieve analysis test).
7. To perform permeability test on the conditioned molding sand.
8. To determine percentage of clay content in molding sand.
9. To make a hook nail of required dimension.
10. To make a square headed bolt.
11. To convert a round bar of mild steel into square shape as per given diagram.
12. To determine the hardness of core and mould by testing.
13. To perform the forging operation on sample by using the power hammer.
14. Preparation of casting mould by using single and split type pattern.
15. To study the working of different types of furnaces used in foundry forging lab.
16. To study different types of casting defects.

Innovative experiments

17. Comparative study of oil fired furnace and pit furnace by fabrication of a hook nail of required dimension.
18. To make a hook nail of required dimension from round and square rods.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 403**
2. Course Title: **MANUFACTURING PROCESSES – II**(Revised in 2019)
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: IV** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Manufacturing Processes I**

10. Course Outcome:

Course Outcome 1: Understand theory of metal cutting, single point cutting tool, mechanism of chip formation, cutting parameters, relationship among cutting forces, tool life and numerical problems

Course Outcome 2: Understand cutting tool materials, types of cutting tool material, properties and their selection, heat generation in metal cutting, tool tip temperature measurement

Course Outcome 3: Classify and understand the principle and basic features, operations performed on -lathe, drilling machine, shaping machine, planing machine and broaching machine etc.

Course Outcome 4: Classify and understand the principle and basic features, operations performed on milling machine, indexing mechanism, lapping and honing machines and their principle of operations, grinding machine and selection of grinding wheel etc.

Course Outcome 5: Understand and classify the various welding processes like gas welding, arc welding, TIG and MIG welding, gas cutting, their process and equipment details, resistance welding, friction welding, soldering and brazing, thermodynamic and metallurgical aspects, HAZ, welding defects.

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Course Outcome 6: Understand the principle and operations and types of unconventional machines and methods of operations, process parameters along with applications

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**tal Cutting theory**: Single point cutting tool nomenclature, geometry, Merchants circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems of Merchant's analysis, tool wear and tool failure, tool life, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation, problems on tool life evaluation, Cutting tool materials: Desired properties, types of cutting tool materials – HSS, carbides coated carbides, ceramics cutting fluids. Desired properties, types and selection. Heat generation in metal cutting, factors affecting heat generation. Heat distribution in tool and W/P. Measurement of tool tip temperature.	08
2.	**ntre lathe, Turret and capstan Lathe, shaping, planning machines and Drilling machines**: Classification, constructional features of turret and capstan lathe, tool layout, shaping m/c, planning m/c, driving mechanisms of lathe, shaping and planning machines, operations on lathe, shaping machine and planning machine. Drilling machines: Classification, constructional features, drilling & related operations, types of drill & drill bit nomenclature, drill materials,	08
3.	**Milling machines**: Classification, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concepts, indexing**,** **inding machines**: Types of abrasives, bonding process, classification, constructional features (Cylindrical and surface grinding), and selection of grinding wheel. Lapping and Honing machines: Principles of operation, construction, applications.	08
4.	**lding operations:** survey of welding processes, position of welding, joint types, **Gas welding:** process and equipment details, **Gas cutting**, process and equipment details, flame types, **Arc welding:** process and equipment details, power sources, electrode details. **TIG & MIG** processes and their parameters. **Resistance welding**: types and details, atomic hydrogen, submerged arc, electroslag, friction welding, soldering and brazing, Thermodynamics and metallurgical aspects in welding ,shrinkages, distortions, residual stresses generation in HAZ and remedies, defects in welding and remedies.	08
5.	**nconventional Manufacturing process:** Introduction, HERF, process parameters – Abrasive jet machining, water jet machining, ultrasonic machining, chemical machining, electro chemical machining, electric discharge machining, electron beam machining, plasma arc machining.	08
	Total	**40**

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12.Suggested Books:

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1.	**Manufacturing Science** by Amitabha Ghosh and Mallik, affiliated East West Press.
2.	**Workshop Technology** by Hazara Choudhry, Vol-II, Media Promoters & Publishers Pvt. Ltd.
3.	**Production Technology** by R.K.Jain, Khanna Publications, 2003.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 404** (Revised 2019)
2. Course Title: **MECHANICAL MEASUREMENTS AND METROLOGY**(Revised in 2019)
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: IV** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Nil**

10. Course Outcome:

Course Outcome 1: Understand different mechanical standards and their principle of measurement and apply the knowledge of tool to solve practical problems.

Course Outcome 2: Understand the basics of limits, fits and tolerances and apply its knowledge.

Course Outcome 3: Understand the construction of the comparators and apply its techniques of measurement

Course Outcome 4: Understand the concept of angular measurement and terminologies of screw thread and gears and apply its applications

Course Outcome 5: Understand the basics of measurement system and principle of transducers and its application.

Course Outcome 6: Understand working principle of force, torque, pressure, temperature and strain measurement systems.

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**STANDARDS OF MEASUREMENT**: Standards of length - International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standards, transfer from line standard to end standard, calibration of end bars (Numerical), Slip gauges, Indian (M-87, M-112), Numerical problems on building of slip gauges.	06
2.	**SYSTEM OF LIMITS, FITS, TOLERANCES AND GAUGING:** Definition of tolerance, Specification in assembly, Principle of inter changeability and selective assembly, compound tolerances, accumulation of	07

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	tolerances, geometrical tolerance, positional -tolerances, definition of fits, types of fits and their designation, hole basis and shaft basis of system, classification of gauges, **Design of gauges**: Taylor's principle, Tolerance analysis in manufacturing and assembly.	
3.	**COMPARATORS AND MEASUREMENT OF ANGLES, SCREW THREADS AND GEARS:** Mechanical comparators -Johnson Mikrokator, Sigma Comparator, dial gauge indicator, Optical Comparators, Zeiss ultra optimeter, Electric and Electronic Comparators, LVDT, Pneumatic Comparators, back pressure gauges, Solex Comparators. Angular measurements, Bevel Protractor, use of angle gauges, (numericals on building of angles). Terminology of screw threads, measurement of major, minor pitch, angle and effective diameter of screw threads, 2-wire and 3-wire methods, gear terminology, use of gear tooth Vernier calliper and gear tooth micrometer. Principle of interferometer, optical flats.	**08**
4.	**MEASUREMENTS AND MEASUREMENT SYSTEMS:** Generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response. Errors in Measurements. Form and finish measurement.	**06**
5.	**MEASUREMENT OF FORCE, TORQUE, PRESSURE, TEMPERATURE AND STRAIN:** Analytical balance, proving ring, Torque measurement: Prony brake, hydraulic dynamometer. Pressure Measurements: Bridgeman gauge, Mcloed gauge, Pirani Gauge.Temperature measurements: Resistance thermometers, thermocouple,Optical Pyrometer. Strain Measurements: Strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement .	**08**
	Total	**35**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	"Engineering Metrology" by R.K.Jain, Khanna Publishers.
2.	"Mechanical measurements" by Beckwith Marangoni and Lienhard, Pearson Education.
3.	"Industrial Instrumentation" Alsutko, Jerry. D.Faulk, Thompson Asia Pvt. Ltd.
4.	"Engineering Metrology" by I.C.Gupta, Dhanpat Rai Publications, Delhi

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 405**
2. Course Title: **KINEMATICS OF MACHINES**(Revised in 2019)
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: IV** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Nil**

10. Course Outcome:

Course Outcome 1: Differentiate between linkage, mechanism and machine and find out the degree of freedom of various linkages.

Course Outcome 2: Find out the inversions of four-bar mechanisms, identify the different mechanisms like quick return mechanisms, straight line motion mechanisms, etc.

Course Outcome 3: Find out the velocity and acceleration of different parts in a mechanism by graphical and instantaneous center method.

Course Outcome 4: State the various terminologies of spur gears, law of gearing, interference, etc

Course Outcome 5: Find out the velocity ratio in simple, compound and epicyclic gear trains.

Course Outcome 6: Identify the various types of cams and followers and plot velocity and acceleration time curves for different follower motion and draw the suitable cam profiles.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION: DEFINITIONS:** Link or element, kinematic pairs, degrees of freedom, Grubler's criterion, Kinematic chain, Mechanism, structure, Mobility of Mechanism, Inversion, Machine. **Kinematic chains and inversions**: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.	08
2.	**MECHANISMS:** Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. **Straight line motion mechanisms**- Peaucellier's mechanism and Robert's mechanism. **Intermittent Motion mechanisms**– Geneva mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Steering Gear Mechanism: Davis and Ackerman steering gear mechanism.	08
3.	**VELOCITY AND ACCELERATION ANALYSIS OF MECHANISMS:** Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons, Relative velocity and acceleration of particles in a common link, relative velocity and accelerations of coincident Particles on separate links- Coriolis component of acceleration. Angular velocity and angular acceleration of links. Kennedy's Theorem, Determination of linear and angular velocity using instantaneous center method **KLEIN'S CONSTRUCTION:** Analysis of velocity and acceleration of single slider crank mechanism.	11
4.	**SPUR GEARS AND GEAR TRAINS:** Gear terminology, law of gearing, Characteristics of involute action, Path of contact, Arc of contact, Contact ratio, Interference in involute gears, Methods of avoiding interference, Back lash, Comparison of involute and cycloidal teeth. Simple gear trains, Compound gear trains for large speed reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains.	10
5.	**CAMS:** Types of cams, Types of followers, Displacement, Velocity and Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-faced follower, Disc cam with oscillating roller follower, Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.	08
	Total	45

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	"Theory of Machines", Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi.
2.	"Theory of Machines", Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi.
3.	"Theory of Machines & Mechanisms", Shigley. J. V. and Uickers, J.J., OXFORD University press.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 406**
2. Course Title: **STRENGTH OF MATERIALS**(Revised in 2019)
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: IV** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Engineering Mechanics**

10. Course Outcome:

Course Outcome 1: Understand the fundamentals of stress and strain developed in deformable bodies.

Course Outcome 2: Describe various properties of materials and analyze problems involving volumetric strain and thermal stresses.

Course Outcome 3: Describe the fundamental difference and design thin and thick cylinders, columns and struts, various loadings on members.

Course Outcome 4: Analyze the problems involving pure bending and pure torsion, also design elements involving such loadings.

Course Outcome 5: Describe and analyze Shear force and Bending Moment in the member and also understand the effect generated due to the same.

Course Outcome 6: Understand, describe and analyze the members involving the combined loadings.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**Simple stress and strain:** Introduction, stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation - behavior in Tension for Mild steel and non ferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position.	07
2.	**Stress in composite section:** Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses and thermal stress in composite bars **Compound stresses:** Introduction, Principal of complementary shear stress, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress.	10
3.	**Bending moment and Shear force in beams**: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads, uniform distributed load (udl) and couple for different types of beams, Point of contraflexure.	07
4.	**Bending and Torsion of shafts:** Introduction, theory of simple bending, relationship between bending stresses and radius of curvature, relationship between bending moment and radius of curvature, moment carrying capacity of a section, Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts. **Deflection of beams:** Introduction, differential equation for deflection, equations for deflections, slope and moments, double integration method, Macaulay's method.	11
5.	**Thick and thin cylinders:** Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume), Thick cylinders subjected to internal and external pressures (Lame's equation), (compound cylinders not included), Efficiency of joint. **Elastic stability of columns:**	10

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	ıtroduction to columns, Euler's theory for axially loaded elastic long columns, derivation of Euler's load for various end conditions, limitations of Euler's theory, Rankine's formula	
	Total	**45**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	**"Mechanics of Materials"** by R.C.Hibbeler, Printice Hall, Pearson Edu., 2005
2.	**Iechanics of materials"**, James.M.Gere, Thomson, Fifth edition 2004.
3.	**"Mechanics of materials"**, S.I. Units, Ferdinand Beer & Russell Johnstan, TATA MacGrawHill-2003.
4.	"**Engineering Mechanics of Solids**" Egor.P. Popov, Pearson Edu. Indi
5.	**"Strength of Materials" ,** S.S.Bhavikatti, Vikas publications House - Pvt. Ltd
6.	Brawand et al., "Aerodynamics of heavy vehicles, Trucks Buses and trains-Vol-41", Springer.

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 407** (Revised in 2019)

2. Course Title: **FLUID MECHANICS**

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 4 **7.** Semester**: IV** **8.** Subject Area**: CC**

9. Pre-requisite**:**

10. Course Outcomes:

Course Outcome 1: Understand the basic concept of fluid flow.

Course Outcome 2: Interpret and analyze the condition of fluid at rest and study the concept of dimensional analysis, similitude and model studies.

Course Outcome 3: Understand and analyze the fluid kinematics.

Course Outcome 4: Describe the formulation for fluid dynamics and study the different fluid measurement devices.

Course Outcome 5: Study and analyzing the different flow regimes condition.

Course Outcome 6: Analyze the different major and minor losses in pipe flow and understanding the concept of boundary layer and flow over submerged bodies.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**roduction:** Fluids and continuum; Physical properties of fluids: Viscosity, Compressibility, Surface Tension, Capillarity, Vapour Pressure; Cavitation; Classification of fluids including rheological classification.	04
2.	**Fluid Statics:** Pascal's law; Pressure-density-height relationship; Measurement of pressure by Manometers and mechanical gauges; Pressure on plane and curved surfaces; The Hydrostatic law; Total Pressure and Centre of pressure; Buoyancy and floatation; Stability of immersed and floating bodies. **Dimensional Analysis:** Units and Dimensions, Dimensional analysis, Rayleigh's method, Buckingham's Π theorem, Important dimensionless numbers used in fluid mechanics and their significance. **Hydraulic Similitude and Model Studies:** Model and prototype; Similitude; Geometric, Kinematic and Dynamic similarity; Model Laws; Un-distorted model studies.	10
3.	**Fluid Kinematics:** Description of Fluid flow: Lagrangian and Eulerian approach; Types of fluid Flows: Steady and unsteady, Uniform and non-uniform, Laminar and turbulent flows, 1, 2 and 3-D flows; Stream lines, Path lines and Streak lines; Stream tube; Acceleration of a fluid particle along a straight and curved path; Rotation, Vorticity and Circulation; Elementary explanation of Stream function and Velocity potential; Flow net characteristics. **Fluid Dynamics:** Concept of control volume and control surface, Gauss divergence theorem, Reynolds Transport Theorem, continuity equation, Body forces and surface forces in fluid, Introduction to Navier-Stokes Equations, Bernoulli's equation and its applications, Introduction to energy equation. **Fluid Measurement:** Flow measurements, determination of coefficients of discharge, velocity and contraction and energy loss. Orifices and Mouthpieces. Notches and Weirs.	10
4.	**Laminar Flow:** Introduction, Reynolds Experiment**;** Relationship between shear stress and pressure gradient; Flow between parallel plates; Hagen Poiseuille Law; Kinetic energy and Momentum correction factors; Stokes law; Transition from laminar to turbulent flow. **Turbulent Flow:** Turbulence; loss of head due to friction in pipe flow-Darcy Equation; Characteristics of turbulent flow; Reynolds Equation for turbulent flow; Eddy viscosity and velocity distribution in turbulent flow; Hydro-dynamically Smooth and rough boundaries	10
5.	**Flow Through Pipes:** Introduction; loss of energy in pipes; Major energy losses; Minor energy losses; Flow in sudden expansion, contraction, diffusers, bends, valves and siphons	10

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	Boundary Layer Analysis: Introduction; Boundary layer thickness, Displacement thickness, momentum thickness, Energy thickness; Boundary layer over a flat plate; Laminar boundary layer; Application of Von-Karman Integral Momentum Equation; Turbulent boundary layer; Laminar sub-layer; Boundary layer separation and its control. **w Past Submerged Bodies:** Drag and lift, Types of drag force, Drag on sphere, Cylinder and airfoil; Circulation and Lift on a cylinder and airfoil; Magnus effect.	
	Total	**44**

12. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Som and Biswas: Introduction to Fluid Mechanics and Machines, TMH.
2.	Modi and Seth: Fluid Mechanics and Fluid Machines
3.	Munson, Bruce R, Donald F Young and T H Okishi, Fundamentals of Fluid Mechanics, 2nd ed, Wiley Eastern.
4.	R J Fox: Introduction to Fluid Mechanics.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 411**
2. Course Title: **MACHINE SHOP LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 1 **7.** Semester: **IV** **8.** Subject Area: **CC**
9. Pre-requisite: **Basics of Workshop, Manufacturing Processes**

10. Course Outcome:

Course Outcome 1: To understand and apply the metal cutting operations on Machines like Lathe ,Shaper and study/analyse the chips formation during these processes/operations.

Course Outcome 2: To understand and apply various surface finishing techniques.
For external surface: Surface Grinding Machine
For internal surface : Tapping &Drilling Machine

Course Outcome 3: To understand the design &development of Spur Gear with the help of Milling Machine.

Course Outcome 4: To understand &apply the metallurgical &joining processes e.g. TIG MIG &Electric Arc Welding, which is useful/applicable in daily/professional life.

11. List of Experiments:

Note: Students are required to perform minimum 12 experiments out of these 14 experiments.

1. To perform step turning and tapper turning on lathe machine tool.

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2. To perform thread cutting and knurling operations on lathe machine tool.

3. To perform machining of flat surface using shaper machine tool.

4. Manufacturing of spur gear using milling machine tool.

5. To compare various types of chips produced by turning of steel and cast iron work piece.

6. To perform drilling operation on bench drilling machine tool.

7. To perform tapping operation using tapping tool.

8. To perform grinding operation using a surface grinding machine.

9. To study quick return mechanism of shaper machine tool

10. To prepare a bead-on-plate using TIG process.

11. To prepare a bead-on-plate using MIG process.

12. To perform an oxy-acetylene gas cutting operation.

13. To perform micro-structural study of TIG weld.

14. To perform micro-structural study of MIG weld.

15. To perform thread cutting and knurling operations on CNC lathe machine.

16.To study the various welding process by robotic welding machine.

17.To study the laser cutting process of materials

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 413**

2. Course Title: **MEASUREMENTS AND METROLOGY LAB**

3. Contact Hours: **L: 0** **T: 0** **P: 3**

4. Examination Duration (Hrs.): **Mid** 3 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **PSM** 25

6. Credits**:** 1 **7.** Semester**: IV** **8.** Subject Area**: CC**

9. Pre-requisite**:** **Basics of Measurements and Metrology**

10. Course Outcome:

Course Outcome 1: Understand the basic concept of measurement and metrology instruments and apply the knowledge of basic measurements instruments such as Vernier caliper, Micrometer, Sine bar, bevel protractor

Course Outcome 2: Understand the concept of measuring and apply the knowledge in determining pressure gauge, thermocouple, LVDT, LOAD cell

Course Outcome 3Apply the knowledge of force measurement using Lathe tool dynamometer, Drill tool dynamometer and Toolmakers microscope

Course Outcome 4: Understand the precision and relative error in measurements and sources of measurements

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11.List of Experiments:

Note: Students are required to perform minimum 12 experiments out of these 14 experiments.

1. Study and measurement by Vernier Calliper

2. Study and measurement by micrometer

3. Calibration of micrometer using slip gauges set

4. Study and angle measurement by sine bar

5. Study and angle measurement by bevel protractor

6. Measurement of pitch, thread angle and diameters of a screw thread using tool maker's microscope.

7. Determination of strain using strain gauge transducer

8. To study the performance characteristics of a load cell

9. To study the performance characteristics of a thermocouple

10. Study of linear variable differential transformer (LVDT)

11. Measurement of cutting tool force using Lathe tool dynamometer

12. Measurement of cutting tool force using Drill tool dynamometer

13. Study of various types of gauges

14. Calibration of pressure gauge using dead weight tester (DWT)

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 417**

2. Course Title: **FLUID MECHANICS LAB**

3. Contact Hours: **L: 0** **T: 0** **P: 3**

4. Examination Duration (Hrs.): **Mid** 3 **End** 3

5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25

6. Credits: 1 **7.** Semester: **IV** **8.** Subject Area: **CC**

9. Pre-requisite: **Fluid Mechanics**

10. Course Outcome:

Course Outcome 1: Understand and apply the basic concept of fluid flow for finding the different fluid properties.

Course Outcome 2: Understand and analyze the friction factor and losses when real fluid flow through pipe.

Course Outcome 3: Understand and calculate the co-efficient of discharge through various fluid measuring devices.

Course Outcome 4: Understand the different flow regimes and determine the Reynolds number.

11. List of Experiments:

Note: Students are required to perform minimum 14 experiments out of these 16 experiments.

1. To measure the surface Tension of a liquid.

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2. To measure the Pressure head of water in a pipeline by means of a U-tube.

3.To Determine the Metacentric height of a Ship model experimentally.

4. Determination of coefficient of friction of flow in a pipe.

5. Determination of minor losses in flow through pipes.

6. To determine the coefficient of discharge of orifice plate meter.

7. To determine the coefficient of discharge of venturi meter.

8. To study the flow behavior in pipe bend and to calibrate the pipe bend from discharge measurement.

9. To study the transition from Laminar to Turbulent flow .

10. To verify Darcy's Law and to find out the coefficient of permeability of the given medium.

11. Reynolds Dye Experiment.

12. Flow over Rectangular Notch.

13. Flow over Triangular Notch.

14. Bernoulli's Experiment.

Innovative Experiments

15. To determine C_c (coefficient of contraction), C_v (coefficient of velocity) and C_d (coefficient of discharge) for flow through a circular orifice.

16. To measure surface of mixture of miscible liquids at different temperatures by capillary rise method.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 501** (Revised-2019)

2. Course Title: **HEAT AND MASS TRANSFER**

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 4 **7.** Semester**:V** **8.** Subject Area**: CC**

9. Pre-requisite**:** **Basic Thermodynamics**

10. Course Outcomes:

Course Outcome 1: Understand the basics modes of heat transfer, conduction, convection and radiation with or without heat generation in 2D and 3D, critical thickness of insulation and basics of transient conduction.

Course Outcome 2: Describe the heat transfer in extended surfaces (FINS) of uniform cross-section without heat generation.

Course Outcome 3: Analyses the application of dimensional analysis for free convection in vertical, horizontal and inclined flat plate, vertical and horizontal cylinders and sphere.

Course Outcome 4: Understand the various correlations for hydro dynamically and thermally forced convections over flat plates, over a cylinder and sphere.

Course Outcome 5: Design of heat exchangers using LMTD and NTU method, And their practical applications**.**

Course Outcome 6: Understand the concept of mass transfer theories, condensation and boiling phenomena.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1	**INTRODUCTORY CONCEPTS AND DEFINITIONS**: Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer; combined heat transfer mechanism. Analogy of Heat flow rate with electric current flow. **CONDUCTION** Derivation of general three dimensional conduction equation in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation). One dimensional conduction equations in rectangular, cylindrical and spherical coordinates for plane and composite walls. Overall heat transfer coefficient. Thermal contact resistance. Critical thickness of insulation without heat generation, Thermal resistance concept & its importance. **TRANSIENT CONDUCTION**: Lumped Capacitance, Biot and Fourier number, Heissler chart	**12**
2.	**FINS**: Heat transfer in extended surfaces of uniform cross-section without heat generation, Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and effectiveness. Numerical problems.	**5**
3.	**FORCED CONVECTIONS**: External and internal flow, Role of boundary layer, Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Reynold's analogy between heat transfer and fluid flow. Use of various correlations for hydro dynamically and thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems. **FREE OR NATURAL CONVECTION**: Application of dimensional analysis for free Convection physical significance of Grashoff number; use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, Numerical problems.	**10**
4.	**RADIATION HEAT TRANSFER**: Thermal radiation; definitions of various terms used in radiation heat transfer; Stefan-Boltzman law, Black and gray body, Kirchoff's law, Planck's law and Wein's displacement law. Method of radiation network. Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; effect of radiation shield; intensity of radiation and solid angle; Lambert's law; radiation heat exchange between two finite surfaces-configuration factor or view factor. Numerical problems.	**7**

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5.	**HEAT EXCHANGERS**: Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems. **CONDENSATION AND BOILING**: Types of condensation (discussion only) Regimes of pool boiling, Mass transfer definition and terms used in mass transfer analysis, Ficks First law of diffusion (no numerical).	**8**
	Total	**42**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Fundamentals of heat and mass transfer, Frenk P. Incropera and David P. Dewitt, John Wiley and son's.
2.	Heat transfer, P.K. Nag, Tata McGraw-Hill Education
3.	Heat transfer, a practical approach, Yunus A- Cengel Tata McGraw Hill
4.	Principles of heat transfer, Kreith Thomas Learning.
5	Heat Transfer, J P Holman, McGraw Hill Publications

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 502**

2. Course Title: **DESIGN OF MACHINE ELEMENTS-I**(Revised-2019)

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 3 **7.** Semester**: V** **8.** Subject Area**: CC**

9. Pre-requisite**:** **Engineering Mechanics, Mechanics of Material**

10. Course Outcomes:

Course Outcome 1: Understand the general considerations, design specifications, common engineering materials and different phases involved in machine design.

Course Outcome 2: Discuss the BIS codes, various standards and failure modes including stress concentration effect to design machine elements and mechanical components.

Course Outcome 3: Analyze the stresses induced in a machine element or mechanical components and apply the various theories for safe design under static and dynamic loading.

Course Outcome 4: Design shafts and keys according to ASME code.

Course Outcome 5: Describe the applications of various mechanical joints and associated terminologies.

Course Outcome 6: Design riveted, bolted and welded joints including eccentric loading.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**Introduction:** Introduction to Mechanical Engineering Design, Phases of design, Factors influencing design, Selection of Materials, Different materials used in engineering applications like CI, Steels, Alloy steels, Mechanical Properties, Preferred numbers, Codes for design-Bureau of Indian Standards (BIS)-codes.	08
2.	**Design for Static Loading:** Simple stresses in machine members, Stress Tensor, stresses due to axial, bending, torsional loads, combination of stresses acting on machine members – their effects, Principal Stresses, Static loads and Factor of Safety, Theories of failure, Failure of Brittle & Ductile Materials. Stress Concentration.	09
3.	**Design for Fatigue Strength**: Introduction- S-N Diagram, Low Cycle Fatigue, High Cycle Fatigue, Endurance Limit, Endurance Limit. Modifying Factors: Size effect, Surface effect, Stress Concentration effects. Fluctuating Stresses, Goodman and Soderberg relationship; Stresses due to Combined Loading, Cumulative Fatigue Damage.	09
4.	**Design of Shafts and Keys**: Torsion of Shafts, Design for strength and Rigidity with Steady loading, ASME & BIS codes for Power Transmission shafting, Shafts under Fluctuating loads and Combined loads. Keys: Types of keys, Design of Keys.	09
5.	**Design of Riveted, Welded, and threaded Joints :** Types, design of riveted joints. Boiler shell riveting, eccentric loading, Strength of Butt, parallel, transverse welds, eccentrically loaded welded joint subjected to torsion & Bending moment, Design of threaded fasteners, thread forms and threaded fastener types and materials, bolt tightening and initial tension, static and group of bolts.	10
	Total	45

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Design of Machine Elements: V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi.
2.	Mechanical Engineering Design: Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition.
3.	Design of Machine Elements: M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Pearson Education.
4.	Machine Design: Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 503** (Revised-2019)

2. Course Title: **DYNAMICS OF MACHINES**

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 4 **7.** Semester**: V** **8.** Subject Area**: CC**

9. Pre-requisite**:** **Kinematics of Machines**

10. Course Outcomes:

Course Outcome 1: Differentiate between static and dynamic problems as encountered in practice and apply the correct approach in solving the same.

Course Outcome 2: State and explain the various principles like principle of virtual work, D'alembert's principle and concept of equivalent offset inertia force.

Course Outcome 3: Identify the static and dynamic unbalance present in the system and the methods of balancing the primary and secondary forces.

Course Outcome 4: Construct the turning moment diagrams for various engines and determine the dimensions of flywheel to control the fluctuation of energy.

Course Outcome 5: Classify the various types of governors used in engines and explain various terms like sensitiveness, hunting, isochronisms relating to governors.

Course Outcome 6: State the role of gyroscopic couple in turning of aeroplanes and various gyroscopic effects produced in ships and automobiles.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**tic Force Analysis**: Introduction: Static Equilibrium, Equilibrium of Two and Three Force Members, Members with Two Forces and Torque, Free Body Diagrams, Principle of Virtual Work, Static Force Analysis of Four Bar Mechanism and Slider-Crank Mechanism without friction.	08
2.	**ynamic Force Analysis**: D'Alembert's Principle, Inertia Force, Dynamic Force Analysis of Four-Bar Mechanism and Slider Crank Mechanism, Dynamically Equivalent Systems, Turning Moment Diagrams and Flywheels, Fluctuation of Energy, Determination of size of flywheels.	09
3.	**Friction and Belt Drives**: Definitions, Types of Friction, Laws of friction, Friction in Pivot and Collar Bearings, clutches. lt Drives: Flat Belt Drives, Ratio of Belt Tensions, Centrifugal Tension, Power Transmitted, Length of Belt.	08
4.	**Balancing of Rotating and Reciprocating Masses**: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes, Balancing of Several Rotating Masses by Balancing Masses in Same plane and in Different planes. Inertia Effect of Crank and Connecting rod, Single Cylinder Engine, Balancing in Multi Cylinder-inline engine (Primary & Secondary forces), V-type Engine, Radial Engine – Direct and Reverse Crank Method.	10
5.	**vernors and Gyroscope** : Types of Governors, Force Analysis of Porter and Hartnell Governors, Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power. Vector Representation of Angular Motion, Gyroscopic Couple, Effect of Gyroscopic Couple on Ship, Plane Disc, Aero plane, Stability of Two Wheelers and Four Wheelers. Application of Gyroscope.	10
	Total	45

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	**Theory of Machines**: Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi.
2.	**Theory of Machines**: Sadhu Singh, Pearson Education.
3.	**Theory of Machines,** Thomas Bevan, CBS Publication.
4.	**Mechanisms and Dynamics of Machinery,** J. Srinivas, Scitech Publications, Chennai.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 506**
2. Course Title: **FLUID MACHINERY**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **V** **8.** Subject Area: **CC**
9. Pre-requisite: **Fluid Mechanics**

10. Course Outcomes:

Course Outcome 1: Understand the basic concept of Impact of Jet on various plates and apply to problems.

Course Outcome 2: Understand the basic concept of construction and working of Impulse Turbine and apply to problems.

Course Outcome 3: Understand the basic concept of construction and working of Reaction Turbine and apply to problems

Course Outcome 4: Understand the basic concept of construction and working of Centrifugal pumps and apply to problems.

Course Outcome 5: Understand the basic concept of construction and working of Reciprocating pumps and apply to problems.

Course Outcome 6: Understand the basic concept of construction and working of Miscellaneous Hydraulic Machines and apply to problems.

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**IMPACT OF JETS:** Introduction ; Force exerted on a stationary flat plate held normal and inclined to the jet , Force exerted on a stationary Curved plate, plate, Force exerted on a moving flat plate held normal and inclined to the jet, Force exerted on a moving Curved plate when the plate is moving in the direction of jet, Problems.	07

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2.	**HYDRAULIC TURBINES:** Classification, Different efficiencies, Pelton turbine – velocity triangles, design parameters, Maximum efficiency. Francis turbine - velocity triangles, design parameters, runner shapes for different blade speeds. Draft tubes- Types and functions. Kaplan and Propeller turbines - velocity triangles, design parameters, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Specific Speed. Problems.	**09**
3.	**CENTRIFUGAL PUMPS:** Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel, Specific Speed. Problems.	**09**
4.	**POSITIVE DISPLACEMENT PUMPS:** Reciprocating pump theory, Slip and coefficient of discharges, Indicator diagram, Effect and acceleration, Work saved by fitting air vessels, Comparison of centrifugal and reciprocating pumps, Positive rotary pumps, Gear and Vane pumps, Performance characteristics.	**09**
5.	**OTHER MACHINES:** draulic accumulator, Special duty pumps, Intensifier, Hydraulic press, Lift and cranes, Theory of hydraulic coupling and torque converters, Performance characteristics. Water Lifting Devices : Hydraulic ram, Jet pumps, Air lift pumps.	**08**
	Total	**42**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	An Introduction to Energy Conversion, Volume III, Turbomachinery, V. Kadambi and Manohar Prasad, New Age International Publishers.
2.	Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd.
3.	Principals of Turbomachines, D. G. Shepherd, The Macmillan Company.
4.	Fluid Mechanics & Thermodynamics of Turbomachines, S. L. Dixon, Elsevier.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 505**

2. Course Title: **INDUSTRIAL ENGINEEING**

3. Contact Hours: **L: 3** **T: 0** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits 3 **7.** Semester**: V** **8.** Subject Area**: CC**

9. Pre-requisite**:** **Nil**

10. Course Outcome:

Course Outcome 1: Understand the concept of Industrial Engineering and determine the methods to improve productivity.

Course Outcome 2: Understand the approach used in Work-Study and Method Study to analyze the study in terms of charts and work measurement techniques.

Course Outcome 3: Study and analyze the time study equipments and to determine the standard time & performance.

Course Outcome 4: Understand the material management techniques in plant & determine the economic order quantity in relation to management of materials.

Course Outcome 5: Analyze and understand the importance of ergonomics and production planning approach to industrial design.

Course Outcome 6: Understand the methods of forecasting and different estimating & costing function for sustainability of business.

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11.Details of Course:

nit No.	Contents	Contact Hours
1.	**PRODUCTIVITY:** Definition of productivity, factors affecting productivity, productivity of man, machine, materials, total productivity, methods to improve productivity. **PLANT LOCATION & LAYOUT**: Plant layout, location, factors affecting the choice of location, Objectives of facility layout, Influencing factors of plant layout, Types of facility layout. Selection of plant site, Design of work places, influence of climate on human efficiency. Influence of noise, vibration and light.	06
2.	**METHOD STUDY:** Definition, objective & scope, charts to record movements in shop, process charts, flow process charts, Multiple activity charts, two handed process charts, SIMO chart, principles of motion economy. **ork Measurement**: Definition, objectives, techniques of work measurement, work sampling, need of confidence levels, sample size determination, random observation with simple problems.	07
3.	**TIME STUDY:** Definition, time study equipments, selection of jobs, steps in time study, breaking jobs into elements, recording information, rating, standard performance, scales of rating, factors affecting rate of working, allowances, standard time determination(Numerical). **ATERIALS MANAGEMENT:** Objectives and functions, Purchasing function, Purchasing procedure, Make or buy decisions, simple break even analysis, Break even point theory, Obsolete, Scrap & surplus management, Inventory Control, types of inventory, inventory costs, inventory control models, determination of EOQ (under deterministic conditions), safety stock inventory control model (Numerical).	07
4.	**Ergonomics and Industrial Design:** Introduction, general approach to the man-machine relationship, workstation design-working position. **ODUCTION PLANNING AND CONTROL:** Introduction, functions and importance of PPC, aggregate production planning, scheduling. **RECASTING:** Types of forecasting, measuring forecast error, Quantitative methods of forecasting, Time series analysis. (Numerical)	08
5.	**TIMATING & COSTING**: Estimating definition, importance, functions. Costing-definition, aims, difference between estimating & costing, procedure of costing, Classification of costs, Elements of Costs direct & indirect Material costs, direct & indirect Labour costs , prime cost, factory cost, Man Hour rate, Machine Hour rate, Unit rate method.	06
	Total	34

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12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Human Factor Engineering: Sanders & McCormick McGraw Hill Publications.
2.	echanical estimating & Costing - T R banga, S C Sharma, Khanna Publishing house
3.	Work Study and Ergonomics - S Dalela and Sourabh, - Chand Publishers, 3rd edition.
4.	Motion and Time study - Ralph M Barnes; John Wiley, 8th Edition, 1985

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 511** (Revised-2019)

2. Course Title: **HEAT & MASS TRANSFER LAB**

3. Contact Hours: **L: 0** **T: 0** **P: 3**

4. Examination Duration (Hrs.): **Mid** 3 **End** 3

5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25

6. Credits: 1 **7.** Semester: **V** **8.** Subject Area: **CC**

9. Pre-requisite: **Heat and mass transfer**

10. Course Outcome:

Course Outcome 1: Evaluate the rate of heat transfer the composite wall and to see the drop of temperature across each wall.

Course Outcome 2: Understand and evaluate the conduction, convection, radiation & heat exchangers equipments with clear concept.

Course Outcome 3: Evaluate and identify to prove the value of Stefan's Boltzmann constant.

Course Outcome 4: Describe all the major and minor concepts about the heat and mass transfer.

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11. List of Experiments:

1. Determination of Thermal Conductivity of a Metal Rod.
2. Determination of Overall Heat Transfer Coefficient of a Composite wall.
3. Conduction analysis of Single/Double Material Slab/ Sphere/ Cylinder. (**Using Virtual Lab***)
4. To determine the critical radius of insulation.
5. Determination of Stefan Boltzmann Constant.
6. Determination of Emissivity of a Surface.
7. Determination of Effectiveness of a Metallic fin.
8. Determination of Heat Transfer Coefficient in free Convection on a vertical tube.
9. Determination of Heat Transfer Coefficient in Forced Convention Flow through a pin fin.
10. Determination of Heat Transfer Coefficient in Free Convention Flow through a pin fin.
11. Determination of LMTD and Effectiveness in a Parallel Flow Heat Exchangers.
12. Determination of LMTD and Effectiveness in a Counter Flow Heat Exchangers.
13. To determine the overall heat transfer coefficient (U) in the parallel flow and counter flow heat exchanger. (**Using Virtual Lab***)
14. Study of Transient Conduction Heat Transfer.

* http://mfts-iitg.vlabs.ac.in/

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 512 (Revised-2019)**

2. Course Title: **DYNAMICS OF MACHINES LAB**

3. Contact Hours: **L: 0** **T: 0** **P: 3**

4. Examination Duration (Hrs.): **Mid** 3 **End** 3

5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25

6. Credits: 1 **7.** Semester: **V** **8.** Subject Area: **CC**

9. Pre-requisite: **Dynamics of Machine**

10. Course Outcome:

Course Outcome 1: Understand about various links, pairs and other kinematic characteristics of the mechanism and their inversions.

Course Outcome 2: Analyse performance characteristic curves for Watt, Porter and Hartnell Governors.

Course Outcome 3: Analyse various methods of Dynamic and Static Balancing and understand stability using Gyroscopic Effect.

Course Outcome 4: Design and analyse Cam Profile, Gear Trains, flywheels and Friction surfaces.

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11. List of Experiments:

1. Study of various mechanisms with the help of Models.

2. Study and velocity analysis of Elliptical Cam Mechanism. (Virtual Lab NIT Kurukshetra)

3. Study of various links with the help of Models.

4. Position and velocity analysis of Slider crank mechanism with Offset.(Virtual Lab NIT Kurukshetra)

5. Study and draw various inversions of 4- bar chain and single slider crank chain.

6. To study the velocity and acceleration of various links of 4-bar chain graphically.

7. Determination of coefficient of friction for various surfaces.

8. Conduct experiment on Hartnell governor to prepare performance characteristic curves.

9. Conduct experiment on watt governor to prepare performance characteristic curves.

10. Conduct experiment on porter governor to prepare performance characteristic curves.

11. To study the gyroscopic effect with the help of apparatus.

12. To determine the gyroscopic couple (graphical method).

13. Experiment on Static balancing machine for static balancing.

14. Experiment on dynamic balancing machine for dynamic balancing.

15. Study of Gear Train mechanisms and calculations of number of teeth.

16. To determine the critical speed of shaft and compare it with the theoretical values.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 516**

2. Course Title: **FLUID MACHINERY LAB**

3. Contact Hours: **L: 0** **T: 0** **P: 3**

4. Examination Duration (Hrs.): **Mid** 3 **End** 3

5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25

6. Credits: 1 **7.** Semester: **V** **8.** Subject Area: **CC**

9. Pre-requisite: **Fluid Machinery**

10. Course Outcome:

Course Outcome 1: Understand and apply the basic concepts of Impact of jet on plates.

Course Outcome 2: Understand and apply the basic concepts of Hydraulic turbines

Course Outcome 3: Understand and apply the basic concepts of Hydraulic turbines.

Course Outcome 4:Understand and apply the basic concepts of Miscellaneous Hydraulic Machines.

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11. List of Experiments:

Note: Students are required to perform minimum 12 experiments out of these 14 experiments.

PART A

1. Impact of jet on flat plate.
2. Impact of jet on curved plate.
3. Performance testing of Pelton Wheel Turbine.
4. Performance testing of Francis Turbine.
5. Performance testing of Multistage Centrifugal Pump.
6. Performance testing of Reciprocating Pump

PART B

7. Study of Pelton wheel turbine.
8. Study of Francis turbine.
9. Study of Kaplan Turbine.
10. Study of Centrifugal pump.
11. Study of Reciprocating pump.
12. Study of Hydraulic Jack.
13. Study of Gear Pump.
14. Study of Vane Pump.
15. Study of Hydraulic Ram for water lifting.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 601** (Revised -2019)

2. Course Title: **REFRIGERATION AND AIR CONDITIONING**

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 4 **7.** Semester**: VI** **8.** Subject Area**: CC**

9. Pre-requisite**:** **Basic Thermodynamics, Applied Thermodynamics**

10. Course Outcomes:

Course Outcome1 : Understand basic concepts ,functions of equipment refrigeration systems.

Course Outcome 2: Understand gas refrigeration system and its performance

Course Outcome 3: Study single and multi -vapour compression refrigeration system

Course Outcome 4: Understand nomenclature of refrigerants and its properties with application.

Course Outcome 5: Understand vapour absorption refrigeration system and analyses its performance over vapour compression systems.

Course Outcome 6: Understand air-conditioning processes using psychrometry and analyses of load calculations.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	GAS CYCLE REFRIGERATION: Introduction, reverse Carnot cycle, Bell Coleman cycle, advantages & disadvtanges of gas refrigeration system. Applications to aircraft refrigeration, Analysis of gas refrigeration and Numericals	**10**
2.	VAPOUR COMPRESSION REFRIGERATION SYSTEM: Simple vapour compression refrigeration cycle, representation on P-h and T-S diagram, factors affecting the performance of VCRC, Actual VCRS & Variable refrigerant flow (*VRF*), Numerical problems. MULTI PRESSURE VAPOUR COMPRESSION SYSTEMS: Multi stage compression, Multi evaporator systems, Cascade systems, calculation, production of solid carbon dioxide, System practices for multistage system.	**10**
3.	REFRIGERANTS: Types of Refrigerants, Nomenclature of refrigerants, selection of Refrigerants, Requirements of Refrigerants, Effects of lubricants in Refrigerants, substitutes of CFC Refrigerants, Mixture Refrigerants-azeotropic mixtures.	**05**
4.	VAPOUR ABSORPTION SYSTEM: Common refrigerant absorbent combinations, Binary mixtures, Ammonia Water Absorption system, Actual vapour absorption cycle and its representation on enthalpy. composition diagram, calculations. Triple fluid vapour absorption refrigeration system. Water - Lithium Bromide absorption chiller	**10**
5.	EQUIPMENTS USED IN VAPOUR COMPRESSION REFRIGERATION SYSTEM: Compressors: Principle, types of compressors, capacity control. Condensers: Types and construction, Expansion devices: Sizing Evaporator: Types & construction. LOAD CALCULATIONS AND APPLIED PSYCHOMETRICS: Internal heat gains, system heat gains, break up of ventilation load and effective sensible heat factor, Bypass factor, cooling load estimate. Psychometric calculations for cooling. Selection of Air conditioning apparatus for cooling and dehumidification, evaporative cooling. Introduction to under floor air distribution(UFAD)	**10**
	Total	**45**

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12. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	'Refrigeration and Air-Conditioning' C. P. Arora, Tata McGraw Hill Publication.
2.	'Refrigeration and Air-Conditioning' W. F. Stoecker, Tata McGraw Hill Publication
3.	'Refrigeration and Air-Conditioning' S C Arora & S Domkundwar, DhanpatRai Publication
4.	'Principles of Refrigeration' Dossat, Pearson.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 602** (Revised -2019)

2. Course Title: **DESIGN OF MACHINE ELEMENTS II**

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25

6. Credits: 4 **7.** Semester: **VI** **8.** Subject Area: **CC**

9. Pre-requisite: **Mechanics of Materials, Design of Machine Element I**

10. Course Outcomes:

Course Outcome 1: Describe construction, understand functions, analyze stresses induced and design springs.

Course Outcome 2: Describe construction, understand functions of flexible elements, analyze stresses induced and design belts.

Course Outcome 3: Describe construction, understand functions, analyze stresses induced and design spur and helical gears.

Course Outcome 4: Describe construction, understand functions, analyze stresses induced and design bevel and worm gears.

Course Outcome 5: Describe construction of bearings; understand different types of lubrication and explain design terms.

Course Outcome 6: Understand the selection of standard dimensions and design bearing.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**SPRINGS** Introduction, Types of springs, material of spring **Helical coil springs:** Stresses in Helical coil springs of circular and non- circular cross sections.Tension and compression springs, springs under fluctuating loads. **Leaf Springs:** Stresses in leaf springs. Equalized stresses, Energy stored in springs. roduction to Torsion, Belleville and Rubber springs	08
2.	**BELTS ROPES AND CHAINS** Introduction, types and materials. **Flat belt:** Length of belt (open and cross), slip & creep centrifugal tension, initial tension, ratio of limiting tension, stresses in belt. **V-belt:** Construction of V-belt, ratio of limiting tensions, Selection of V-belts from manufacture catalogue. **Chain & rope drives:** Introduction.	08
3.	**SPUR AND HELICAL GEARS** Definitions, Terminology, Tooth profiles, Involute full depth & stub system, Force analysis, Stresses in gear tooth, Lewis equation and form factor, Design for strength, dynamic load and wear load, Formative/virtual number of teeth, Beam strength of helical gear tooth.	09
4.	**BEVEL AND WORM GEARS** Definitions, Terminology, Force analysis, Formative number of teeth, Design based on strength, dynamic and wear loads	08
5.	**SLIDING AND ROLLING CONTACT BEARINGS** pes and classification, terminologies, Mechanisms of Lubrication, bearing modulus, Coefficient of friction, Minimum oil film thickness, Heat Generated, Heat dissipated, Bearing Materials, Design of journal bearing, Life, Static & dynamic load capacity, equivalent load, Load-life relationship, Design - finding Life, selection from manufacture's catalogue.	09
	Total	42

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12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Mechanical Engineering Design, Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition.
2.	Design of Machine Elements, V. B Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi.
3.	Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition.
4.	Machine Design, Robert L. Norton, Pearson Education.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 603** (Revised-2019)
2. Course Title: **INTERNAL COMBUSTION ENGINES**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: VI** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Basic Thermodynamics, Applied Thermodynamics**

10. Course Outcomes:

Course Outcome 1: To understand the terminology and fundamental concepts of traditional and advanced Internal Combustion Engines.

Course Outcome 2: To analyze the heat Balance sheet and Engine performance and fuel characteristic.

Course Outcome 3: To understand and analyze of Engine working principle based on Otto cycle and Diesel cycle.

Course Outcome 4: To understand the Carburization process, calculation of Air-Fuel ratio, Supercharging, Turbo charging, different valve mechanism

Course Outcome 5: understand and apply the different engine components like governor, fuel feed pump, fuel injector, spark plug etc.

Course Outcome 6: To apply the principle of Measurement of CO_x and NO_x from engine exhaust and their control and measurement of power

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION TO IC ENGINES:** Definition of Engine; Heat Engine, Classification & Nomenclature, Performance Parameters, Air Standard Cycles- Carnot Cycle, Sterling Cycle, Ericson Cycle, Otto Cycle, Diesel cycle, Dual Cycle, Thermodynamics Analysis of these cycles. ORKING OF I.C. ENGINE: Working of 2 and 4 Stroke Petrol & Diesel Engines, Comparison of Two Stroke & Four Stroke Engines, Comparison of Petrol & Diesel Engines.	07
2.	**FUEL AIR & ACTUAL CYCLES AND THEIR ANALYSIS:** Introduction to Fuel Air Cycles and Their Significance, Composition of Cylinder Gases, Variable Specific Heats, Dissociation, Comparison of Air Standards & Fuel Air Cycles, Effect of Fuel Air Ratio on Operating Variables, Actual Cycles and Their Analysis; Difference Between Actual and Fuel-Air Cycles. **ENGINE FUELS:** Fuels for SI and CI Engine, Important qualities of SI and CI Engine Fuels, alternative fuels, Rating of SI and CI Engine Fuels.	07
3.	**FUEL SUPPLY SYSTEM OF SI ENGINES:** Carburetion, Types of Air Fuel Mixture, Mixture Requirements, A Sample Carburetor and It's Working, Calculation of Air-Fuel Ratio for a Simple Carburetor. **FUEL SUPPLY SYSTEM OF CI ENGINES:** Requirements of Injection Systems, Classification of Injection Systems, Air fuel injection system, Solid Fuel Injection System, Injection Pump, Injection pump governor, Fuel Injector, Nozzle, Spray Formation.	08
4.	**COMBUSTION IN S.I. ENGINES:** Introduction, Fluid dynamics in cylinder, Stages of Combination in S.I. Engine, Flame Front Propagation, Factor Influencing the Flame Speed, Ignition lag and Factors Affecting the Lag, Abnormal Combustion and Knocking. **COMBUSTION IN C.I. ENGINES:**	08

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	Introduction, spray behavior, Stages of Combination in C.I. Engine, Factors Affecting Ignition Delay, Knocking in CI engine, Combustion Chamber Design of CI Engines, Exhaust Gas Recirculation. **SUPERCHARGING:** Introduction, Purpose of Supercharging, Type of Superchargers, Analysis of Superchargers, Performance of Superchargers, Arrangement of Supercharger and its Installation, Turbo charged engines, Supercharging of S.I. & C.I. Engines, Limitations of Supercharging.	
5.	**MEASUREMENT AND TESTING:** Measurement of Friction Power, Brake Power, Indicated Power, Heat Carried by Cooling Water, Heat Carried by the Exhaust Gases, Heat Balance Sheet. **NGINE EMISSION, COOLING AND LUBRICATION:** roduction, Hydrocarbon Emission, CO Emission, NO_x Emission, Particulates, Emission Control Methods. Basics of engine cooling and lubrication. **DVANCED ENGINE CONCEPTS:** Low Temperature Combustion (LTC) to reduce engine emissions. An introduction to various novel engine concepts such as HCCI, PPCI and RCCI.	**10**
	Total	**40**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Internal Combustion Engines By V. Ganesan, Prentice Hall Of India
2.	IC Engines By M.L Mathur & R.P Sharma –Dhanpat Rai Publication.
3.	Willardw. Pulkrabek, “Engineering Fundamental of Internal Combustion Engine”, Prentice Hall International, Inc., New York
4.	Richard Stone, “Introduction to Internal Combustion Engines”, 3rd Edition, MACMILAN, New York
5.	Internal Combustion Engine Fundamentals by J.B. Heywood

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 606**
2. Course Title: **COMPUTER AIDED DESIGN AND MANUFACTURING**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: VI** **8.** Subject Area**: CC**
9. Pre-requisite**: Design, Manufacturing**

10. Course Outcomes:

Course Outcome 1: Understand the basic fundamentals of computer aided design and manufacturing.

Course Outcome 2: To understand 2D & 3D transformations of the basic entities like line, circle, ellipse etc.

Course Outcome 3: To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. & and apply it to visualize how the components look like before its processing.

Course Outcome 4: To understand the fundamentals of Group Technology, Computer Aided Process Planning & Flexible Manufacturing Systems.

Course Outcome 5: To understand Automation & NC machine tools.

Course Outcome 6: To understand NC part programming & apply it for different manufacturing processes

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	Introduction CAD: Design Process, Application of computers in Design, Creating manufacturing database, benefits of CAD. Graphic input, output & display devices.CAD software and Database: Software configuration of a graphics system: functions of a graphics package, Database structure and control, Graphics standard GKS and IGES.	**07**
2.	Geometric Transformations: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrice. Representation of curves and surfaces: Polygon meshed and ruled surfaces: Bezier curves; B spline curves. Geometric Modeling: Wireframe model: solid modeling: representation, volumetric properties, surface modeling.	**07**
3.	oup Technology (GT): Part families; part Classification, Group technology machine cells:. Computer Aided Process Planning: Introduction and benefits of CAPP. Types of CAPP system, Flexible Manufacturing System (FMS) its advantages, components of a FMS system, Introduction to Manufacturing Execution System (MES)	**07**
4.	Introduction to Automation and need and future of NC systems and CAM. Advantages& disadvantages. Classification. Open and closed loop systems. Historical development and future trends. Difference between ordinary and NC machine tools. Methods for improving Accuracy and Productivity.	**07**
5.	NC Part Programming- (a) Manual (word address format) programming. Examples Drilling Robotics- NC machine vs Robots. Types and generations of Robots. Robot applications. Economics, Introduction to Artificial Intelligence for Intelligent manufacturing.	**07**
	Total	**35**

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12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Computer control of Manufacturing systems by Koren
2.	NC Machines by Koren
3.	CAD/CAM by Groover.
4.	CAD/CAM by Groover & Simmers, Prentice Hall of India

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 614**
2. Course Title: **FINITE ELEMENT METHOD**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: VI** **8.** Subject Area**: DE**
9. Pre-requisite**:** **Mechanics of Material**

10. Course Outcomes:

Course Outcome 1: Understand the historical development, concepts and general steps of finite element methods.

Course Outcome 2: Understand the mathematical formulation of engineering problems and apply weighted residual method, Galerkin method, least square method etc. to obtain weak form.

Course Outcome 3: Apply finite element method to structural, fluid and thermal problems.

Course Outcome 4: Apply finite element method to formulate and solve problems in trusses.

Course Outcome 5: Apply finite element method to formulate and solve problems in beams and frames.

Course Outcome 6: Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axi-symmetric and plate bending problems.

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**Introduction to Finite element method:** History, basic ideas in a finite element solution, General finite element solution procedure, Discretization, FEM versus other numerical method techniques, Applications and advantages of FEM.	04

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2.	**Introduction to the Stiffness (Displacement) Method:** Definition of the Stiffness Matrix Derivation of the Stiffness Matrix for a Spring Element, Assembling the Total Stiffness Matrix by Superposition (Direct Stiffness Method), Boundary Conditions, Potential Energy Approach to Derive Spring Element Equations, Numerical problems.	**07**
3.	**One dimensional FE analysis:** One dimensional bar element, elements and numbering scheme, Element stiffness matrix, Global stiffness matrix, load vector, Boundary conditions, computation of stress for a bar element, shape functions, one dimensional linear and quadratic element, Numerical problems	**07**
4.	**Development of Truss Equation:** Stiffness of Truss Members, Analysis of Truss, Plane Frame Analysis, Solution of a Plane Truss, Use of Symmetry in Structure, Inclined, or Skewed, Supports, Numerical Problems. Development of Beam Equations –Introduction, Beam Stiffness, Example of Assemblage of Beam Stiffness Matrices, Examples of Beam Analysis Using the Direct Stiffness Method, Distributed Loading, Numerical Problems	**08**
5.	**Two dimensional FE analysis:** Basic Concepts of Plane Stress and Plane Strain, Isoparametric formulation, Derivation of the Constant-Strain Triangular Element Stiffness Matrix and Equations, Introduction, Derivation of the Linear-Strain Triangular Element Stiffness Matrix and Equations, Example LST Stiffness, Numerical Problems.	**08**
	Total	**34**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Introduction to Finite Elements in Engineering. Chandrupatla and Belegundu,Pearson.
2.	Finite Element Method, with applications in Engineering. Y.M. Desai, T. I. Eldho, A. H. Shah, Pearson.
3.	The Finite Element Method, O.C. Zienkiewicz, Tata McGraw Hill.
4.	Finite Element Method , J. N. Reddy, Tata McGraw Hill.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 615 (Elective II)**

2. Course Title: **COMPUTATIONAL FLUID DYNAMICS**

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 4 **7.** Semester**: VI** **8.** Subject Area**: Fluid**

9. Pre-requisite: Fluid Mechanics, Fluid Machinery

10. Course Outcomes:

Course outcome 1: To understand and able to derive the mass, momentum and energy conservation laws for various flow domain.

Course outcome 2: To understand and able to derive the various turbulence model

Course outcome 3: To develop the skill of Finite volume discretization for diffusion and diffusion-convection problems and be able to apply the solution algorithm.

Course outcome 4: To understand and able to apply the Finite volume method for unsteady flow.

Course outcome 5: To understand and able to apply different boundary conditions depending upon the flow domain.

Course outcome 6: Able to analyses uncertainty and errors in CFD modeling and solution.

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11. Details of Course:

Unit No.	Contents	Contact Hours
1.	vier-Stokes equations in integral form, **Characteristics of Equations**,	**4-01+1= 04**
2.	**rbulence modeling:** Turbulence and its length scales, Law of the wall, Reynolds decomposition and RANS, Mixing length theory, one-two-equation turbulence models***, Concepts of LES and DNS***.	**06+01 =7**
3.	**Finite volume methods: Diffusion problem:** **Convection-diffusion problem:** Steady one-dimensional convection and diffusion, The central differencing scheme, Properties of discretisation schemes, Assessment of the central differencing scheme for convection– diffusion problems, The upwind differencing scheme, The hybrid differencing scheme. **Solution algorithms for pressure---velocity coupling in steady flows:** SIMPLE algorithms. **Test case of flow over flat and inclined plate using commercial software ANSYS-Fluent for skill development.**	**9-1+4= 12**
4.	**Solution of discretised equations:** TDMA, Jacobi iteration method, Gauss–Seidel iteration method, Relaxation methods **The finite volume method for unsteady flows:** Explicit scheme, Crank–Nicolson scheme, The fully implicit scheme, Transient SIMPLE **Implementation of boundary conditions:** Inlet boundary conditions, Outlet boundary conditions, Wall boundary conditions, The constant pressure boundary condition, Symmetry boundary condition, Periodic or cyclic boundary condition. **Test case of flow through pipes /channel using commercial software ANSYS-Fluent for skill development.**	**)-03+04=10**
5.	**Errors and uncertainty in CFD modelling:** Numerical errors, Input uncertainty, Physical model uncertainty, Verification and validation, Guidelines for best practice in CFD. *Concept of modelling of multiphase flow, Introduction to one wa and two way couplings, CFD of Multiphase flow.* ***Test case of free-shear flow using commercial software ANSYS-Fluent for skill development.***	**)-03+05= 11**
	Total	**44**

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12. Suggested Books:

S. No.	Name of Authors /Books /Publisher
1.	H.K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The finite volume methods, 2nd edition, Prentice Hall
2.	David, C. Wilcox, Turbulence Modeling for CFD, 3rd edition, DCW Industries
3.	Ferziger, J. H. and Peric, M., Computational Methods for Fluid Dynamics, 3rd edition, Springer Verlag, Berlin.
4.	Anderson, D.A., Tannehill, J.C. and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer. Taylor & Francis.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 616**

2. Course Title: **Numerical Methods Using MATLAB**

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 4 **7.** Semester**: VI** **8.** Subject Area**: DE**

9. Pre-requisite**:**

10. Course Outcomes:

Course Outcome 1: To execute the basics arithmetic, trigonometric, exponential operations in MATLAB command prompt as well as the MATRIX operations

Course Outcome 2: Able to write and execute the script and function file in MATLAB to solve the simple engineering problems

Course Outcome 3: To understand the basics of numerical differentiation and integration through MATLAB also able to write the MATLAB code to solve ODE and PDE.

Course Outcome 4: Able to write the program for Runge-kutta method, Simpson method, trapezoidal method

Course Outcome 5: Able to write a program to solve the basic flow and heat transfer problem through MATLAB code.

Course Outcome 6: To develop the understanding of the SIMULINK in MATLAB

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	Basics of Matlab: Introduction to Matlab and programming. Knowing the Matlab environment, .m files, workspace, functions, arrays, strings, data input output, plotting and introduction to toolboxes. Introduction to Numerical methods and error analysis.	**04**
2.	Root finding: Open methods and bracketing methods - Bisection method, incremental search, Newton methods (including coding). Roots, poly, polyder, fplot, fzero, polyval, conv, deconv commands. Solution to Von Karmen equation and Colebrook equation for friction factor in fluid flow in a pipe. Solution to transcendental equation for heat transfer.	**05**
3.	Linear Algebra: Matrix operations - addition, subtraction, multiplication and division (matrix and element by element), exponential (matrix and element by element), vectorization. Special Matrices - eye, zeros, magic, ones, Hilbert matrices. Size, length, sum, trace, sqrt, transpose, matrix addressing (: operator), Solution to set of linear algebraic equations, Gauss elimination, LU factorization, Matrix inverse and conditioning number, norm of matrix, Matlab solver \. Solution to a truss problem. Eigenvalue problems.	**10**
4.	Numerical differentiation and integration. Forward difference, central difference, backward difference. Truncation error. Matlab command - grad. Solution to a heat transfer problem with convection - Finite difference method. Newton Cotes formula, Trapezoidal and Simpson's rule of integration. Guass quadrature. Matlab command quad and trapz. Calculation of volume flow rate in a pipe using experimental data	**08**
5.	Ordinary differential equation. Initial value problem, boundary value problem. Euler method, Runge kutta method. Using the inbuilt functions, ode solvers. Application of simlink, Simulation of resonance, Response of second order system , Simulation of quarter model of car.	**10**
	Total	**37**

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12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Applied Numerical Methods with Matlab for Engineers and Scientistss - Steven C Chapra, Tata McGraw Hill.
2.	Getting started with Matlab - Rudra Pratap, Oxford university press.
3.	Applied Numerical Analysis Using Matlab - Laurene V. Fausett, Pearson publication.
4.	S. S. Rao, “Mechanical Vibration”, Pearson/Prentice Hall Publication.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

7. Lab Code: **PME 611 (Revised-2019)**

8. Course Title: **REFRIGERATION & AIR-CONDITIONING LAB**

9. Contact Hours: **L: 0** **T: 0** **P: 3**

10. Examination Duration (Hrs.): **Mid** 3 **End** 3

11. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25

12. Credits: 1 **7.** Semester: **VI** **8.** Subject Area: **CC**

9. Pre-requisite: **Refrigeration and Air-conditioning**

10. Course Outcome:

Course Outcome 1Understand the performance of Domestic/VARS/Cold storage/Ice plant.

Course Outcome 2: Understand the working of Central AC/Window AC/All weather AC.

Course Outcome 4: Determine the COP of AC test Rig/ Refrigeration Test rig/Split AC .

Course Outcome 4: Understand the working of condenser/Evaporator/Compressor/Expansion device.

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11. List of Experiments:

1. Study and performance of domestic refrigerator. Performance study of refrigeration system & determination of COP.
2. Study the performance of Vapour absorption refrigeration and Electrolux refrigerator.
3. Study of an Ice plant and cold storage plant.
4. Calculation/ Estimation of cooling load for large building.
5. Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning.
7. Study and performance of window type air conditioning system.
8. Study of all-weather year - round air conditioning system.
9. Study of defrosting in refrigeration.
10. Study of evaporator and condenser.
11. To study the cut sectional model of reciprocating, rotary and centrifugal compressor.
12. To study the various controls used in Refrigeration and Air conditioning system.
13. To study different psychometric process & chart.
14. To Study working principle of steam jet refrigeration system.
15. To Study and performance of VRF air conditioning systems.
16. To study and design of under floor air distribution (UFAD).

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 616**
2. Course Title: **AUTOMATION AND CNC LAB**

3. Contact Hours: **L: 0** **T: 0** **P: 3**

4. Examination Duration (Hrs.): **Mid** 3 **End** 3

5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25

6. Credits: 1 **7.** Semester: **VII** **8.** Subject Area: **CC**

9. Pre-requisite: **CAD/CAM**

10. Course Outcome:

Course Outcome 1: To understand & analyze the various functions of CNC machine tools.

Course Outcome 2: To understand the programming and safety precautions on CNC machines and design/develop NC codes using G Codes to machine parts to specifications.

Course Outcome 3: To write and simulate manual part program of various turning operation.

Course Outcome 4: To write and simulate manual part program of various milling operation.

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11. List of Experiments:

Note: Students are required to perform minimum 12 experiments out of these 14 experiments.

1. To conduct a brief study on various aspects of CNC Machines.
2. To study the preparatory and miscellaneous function of CNC machine Codes.
3. Write & simulate manual part program of Facing operation on CNC Turning Machine.
4. Write & simulate manual part program of Step Turning operation on CNC Turning Machine.
5. Write & simulate manual part program of Taper Turning operation on CNC Turning Machine.
6. Write & simulate manual part program of Chamfering operation on CNC Turning Machine.
7. Write & simulate manual part program of Corner Radius operation on CNC Turning Machine.
8. Write & simulate manual part program of Drilling operation on CNC Turning Machine.
9. Write & simulate manual part program of contouring operation.
10. Write & simulate manual part program of Milling Profile operation on CNC Milling Machine.
11. Write & simulate manual part program of Milling corner radius operation on CNC Milling Machine.

INNOVATIVE EXPERIMENT:

12. Write & simulate manual part program of contouring operation using by G- codes G70, G71 & G72.
13. Write & simulate manual part program of Circular Pocketing operation using by G- codes G170 & G171.
14. 6 -Axis Robot programming to perform welding operation.

REFERENCE:

Mehta, N. K. (2012). *Machine Tool Design & Numerical Control*. Tata McGraw Hill Education Pte. Limited.

Valentino, J., & Goldenberg, J. (2003). *Introduction to computer numerical control (CNC)*. Englewood Cliffs: Prentice Hall.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 701**
2. Course Title: **MECHANICAL VIBRATIONS**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: VII** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Engineering Mechanics, Dynamics of Machine**

10. Course Outcomes:

Course Outcome 1: Understand the basic concepts, definitions and terminologies used in Mechanical Vibrations.

Course Outcome 2: Understand and analyse the governing equation of motion for undamped free vibration.

Course Outcome 3: Understand and analyze different types of damping system.

Course Outcome 4: Understand and evaluate forced, single degree of freedom, vibration system.

Course Outcome 5: Understand and analyze two degree of freedom system.

Course Outcome 6: Understand the working details and apply the instrumentation for vibration analysis and measurements.

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**Fundamental Of Vibrations:** Definition of Vibration, Causes of Vibration, Effects of Vibration, Nomenclature, Vector Method of representing harmonic motions, Additions of simple harmonic motions (Problems), Beats Phenomenon (Problems), Complex Method of representing harmonic	10

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	motions, Fourier Series (Problems), Elements of a Mechanical Vibratory System ,Classification of Vibrations.	
2.	**Undamped Free Vibrations - (For Single Degree Of Freedom System:** Introduction to undamped free vibration system, , Derivation of differential equation (Newton's Method, Energy Method, Rayleigh's Method, D'Alembert's Principle), Solution of differential equation, Natural frequency of spring mass system, Effect of spring mss on spring mass system, Equivalent spring constant (series and parallel), Torsional Vibrations , Mass- Pulley system, Pendulum, Problems on determination of natural frequency of undamped free vibrations.	**08**
3.	**Damped Free Vibrations- (For Single Degree Of Freedom System:** Introduction to Damped Vibration, Types of Damping (viscous, coulomb, structural, slip), Differential equation for damped Free Vibration with Viscous Damping, Damping ratio, Over-damped system, Critically-damped system, Under Damped System, Damped natural frequency, Logarithmic decrement (Problems), Problems on deriving the equations of motions and determination of damped natural frequency.	**08**
4.	**Forced Vibrations- For Single Degree Of Freedom System: Introduction, Sources of excitation,** Forced vibrations with constant harmonic Excitation (Equation of motion, amplitude ratio, characteristic curves) (Problems), Response of a rotating and reciprocating unbalance system (Problems), Forced Vibration due to excitation of the support, Displacement Transmissibility (Problems), Vibration isolation, Force Transmissibility (Problems)	**09**
5.	**Introduction to Two degree of freedom system:** Vibration of two DOF system (Equation of motion, natural frequency, Amplitude ratio, mode shape) (Problems), Vibration Absorbers, Critical speeds of shafts for a single disc with and without damping, Vibration measuring instruments, Control of Vibrations.	**07**
	Total	**42**

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12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Mechanical Vibrations: V.P. Singh, Dhanpat Rai & Company Pvt. Ltd.
2.	Machanical Vibrations - S.S. Rao, Pearson.
3.	Mechanical Vibrations: G.K. Grover, Nem chand Publication.
4.	Mechanical Vibration Practice with Basic Theory, V. Rama Murthy, Narosa Publishers.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 704**

2. Course Title: **OPERATION RESEARCH AND OPTIMIZATION TECHNIQUES**

3. Contact Hours: **L: 3** **T: 1** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 4 **7.** Semester**: VII** **8.** Subject Area**: CC**

9. Pre-requisite**: Nil**

10. Course Outcomes:

Course Outcome 1: Understand the basic concepts of Operation Research, Linear Programming Problem and apply to problems.

Course Outcome 2: Understand the basic concepts of Transportation problem, Assignment problem and apply to problems.

Course Outcome 3: Understand the basic concepts of Network analysis and apply to problems.

Course Outcome 4: Understand the basic concepts of Game theory and apply to problems.

Course Outcome 5: Understand the basic concepts of Sequencing theory and apply to problems.

Course Outcome 6: Understand the basic concepts of Queuing theory and apply to problems.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION**: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR. **LINEAR PROGRAMMING PROBLEMS**: linear programming (LP) problem-formulation and solution by graphical method. The simplex method-canonical and standard form of an LP problem, slack, surplus and artificial variables, big M method and concept of duality, dual simplex method.	**10**
2.	**TRANSPORTATION PROBLEM**: Introduction; Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases and travelling salesman problem.	**08**
3.	**NETWORK ANALYSIS**: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	**08**
4.	**GAME THEORY**: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **SEQUENCING**: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method.	**10**

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5.	**QUEUING THEORY**: Introduction; Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models - M/M/1 and M/M/C models and their steady state performance analysis. .	**08**
	Total	**44**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Operations Research, P K Gupta and D S Hira, Chand Publications, New Delhi
2.	Operations Research, Taha H A, Pearson Education
3.	Operations Research, A M Natarajan, P Balasubramani, Pearson Education
4.	Introduction to Operations Research, Hiller and Liberman, McGraw Hill

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 706**
2. Course Title: **POWER PLANT ENGINEERING**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4
7. Semester: **VII**
8. Subject Area: **CC**
9. Pre-requisite: **Thermodynamics, IC Engine, Fluid Machinery**

10. Course Outcomes:

Course Outcome 1: Understand the sources of energy, thermodynamic cycles, fuels, load curves, power plant economics and apply to practical problems.

Course Outcome 2:Understand the components of working of steam power plant and analyze the efficiency and heat balance.

Course Outcome 3: Understand the construction, working of diesel power plant and analyze the efficiency.

Course Outcome 4: Understand the construction, working of Gas Turbine power plant and analyze the efficiency.

Course Outcome 5: Understand the construction, working of Hydroelectric power plant and analyze the efficiency of power plant.

Course Outcome 6: Understand the principle of Nuclear energy, construction and working components of nuclear power plant.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**Economics of Power Generation:** Introduction, Load Curve, Load duration curve, load factor, Capacity Factor, Reserve factor, demand factor, diversity factor, plant use factor (Numerical Problems), base load, intermediate load, peak load, fixed cost, variable cost, Depreciation- straight line method, sinking fund method (Numerical Problems), Present worth concept (Numerical Problems), Indian energy scenario.	08
2.	**Steam power plant:** Introduction, Rankine Cycle- Reheating, Regeneration, General layout of steam power plant, Classification, coal and ash circuit, Air and gas circuit, feed water and steam flow circuit, cooling water circuit, component of a modern steam power plant, boilers, boilers mountings and accessories, Draught, steam nozzle, Steam turbines- Simple impulse turbine, Reaction Turbine, Compounding, Velocity Diagram (Numerical Problems), maintenance of steam power plant. Study of Indian Steam Power Scenario.	09
3.	**Diesel Power Plant:** Diesel cycle, Application, Advantages and Disadvantages, General layout, Elements - Air intake and admission system, Exhaust system, Fuel system, Cooling system, Lubrication system, Starting system, diesel plant operation and efficiency (Numerical Problems). **Gas Power Plant:** Layout, Advantages, Disadvantages, Analysis of Gas Power Plant- Efficiency, optimum pressure ratio, Maximum pressure ratio, maximum work (Numerical Problems), Regeneration, Reheating, Intercooling, Components- compressor, combustion chamber, gas turbine, Gas turbine fuels, turbine materials.	10
4.	**Hydro Electric Power Plant and NCER:** Introduction, Principles of working, applications, site selection, Essential elements, classification and arrangements, Hydraulic Turbines, Velocity Diagram (Numerical	08

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	Problems) Introduction to NCER. Study of Indian Hydro Power Scenario	
5.	**Nuclear Power Plant:** Principles of nuclear energy, fission and fusion reactions, Mass defect and Binding energy (Numerical Problems), Basic components of nuclear reactors- Fuel rods, control rods, moderator, coolant, types of Reactors- BWR, PWR,FBR,CANDU. Study of Indian Nuclear Power Scenario.	**07**
	Total	**42**

12.Suggested Books:

S. No.	Name of Authors /Books /Publisher
1.	Nuclear Reactor Engineering By S. Glastone and A . Sesonske.
2.	Power Plant Engineering by P.K. Nag, Tata McGraw Hill.
3.	Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub.House.

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 707**
2. Course Title: **AUTOMOBILE ENGINEERING**

3. Contact Hours: **L: 3** **T: 0** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 3 **7.** Semester**: VII** **8.** Subject Area**: CC**

9. Pre-requisite**:** **Engineering Mechanics**

10. Course Outcomes:

Course Outcome 1: Students will be able to understand about vehicle structure and engines.
Course Outcome 2: Students will be able to understand about engine auxiliary systems
Course Outcome 3: Students will be able to understand about transmission systems
Course Outcome 4: Students will be able to understand about steering, brakes systems
Course Outcome 5: Students will be able to understand about suspension systems.
Course Outcome 6: Students will be able understand about alternative energy sources.

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**VEHICLE STRUCTURE AND ENGINES**: Types of automobiles, vehicle construction and different layouts, chassis, frame and body, resistances to vehicle motion and need for a gearbox, components of engine-their forms, functions and materials.	08

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2.	**ENGINE AUXILIARY SYSTEMS**: Electronically controlled gasoline injection system for SI engines., Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system ,Turbo chargers, Engine emission control by three way catalytic converter system	**08**
3.	**TRANSMISSION SYSYTEMS**: Clutch-types and construction ,gear boxes-manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel –torque converter , propeller shaft, slip joints, universal joints ,Differential, and rear axle, Hotchkiss Drive and Torque Tube Drive.	**09**
4.	**STEERING,BRAKES AND SUSPENSION SYSTEMS :**Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems , Pneumatic and Hydraulic Braking Systems, Antilock Braking System and Traction Control.	**09**
5.	**ALTERNATIVE ENERGY SOURCES**: Use of Natural Gas, Liquefied Petroleum Gas. Bio-diesel, Bio-ethanol , Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance ,Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell.	**08**
	Total	**42**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Kirpal Singh, " Automobile Engineering Vol 1 & 2 ", Standard Publishers
2.	Jain,K.K.,andAsthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi
3.	Automotive mechanics**,** William H Crouse & Donald L Anglin, 10th Edition, Tata McGraw Hill Publishing Company Ltd.,
4.	Automotive Mechanics**,** S. Srinivasan, Tata McGraw Hill

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 714**
2. Course Title: **TOTAL QUALITY MANAGEMENT**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: VII** **8.** Subject Area**: DE**
9. Pre-requisite**: Nil**

10. Course Outcomes:

Course Outcome 1: Understand the basic concepts of Total Quality Management (TQM) and Quality.

Course Outcome 2: Adopt TQM Methodology and describe the contributions of key contributors to TQM.

Course Outcome 3: Apply the tools and techniques used in TQM for continuous improvement.

Course Outcome 4: Apply Benchmarking and business processes to improve management processes.

Course Outcome 5: Analyse QFD, Total Productive maintenance and FMEA stages for Quality.

Course Outcome 6: Understand the importance of Quality systems and standards used in industries.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION:** finition of Quality, Dimensions of Quality, Quality costs - , Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Wheels of TQM, Benefits of TQM, Scope of TQM, Types of customers, Barriers to TQM Implementation. One relevant case study.	07
2.	**TQM PHILOSOPHIES and PRINCIPLES:** ality Management Philosophies: Deming Philosophy, Juran Philosophy, Juran trilogy, Taguchi and his quality loss function,Crosby and quality is free , PDCA and PDSA Cycle, 5S, Kaizen, Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment and performance appraisal One relevant case study.	07
3.	**STATISTICAL PROCESS CONTROL (SPC) and RELIABILITY:** The seven tools of quality, Statistical Fundamentals - Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Software used in SPC, Concept of six sigma, Lean manufacturing., lean six sigma , use of software for project management Reliability definition, bathtub curve, failure rates, hazard function derivation for exponential probability distribution. Reliabilty in series and parallel, system reliability. Introduction to minitab software One relevant case study using minitab.	07
4.	**TQM TOOLS:** Benchmarking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits, maintenance breakdown maintenance, prevention maintenanceTotal Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA. One relevant case study using free software for QFD an FMEA.	07
5.	**QUALITY SYSTEMS:** Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 - Concept, Requirements and Benefits. BIS Introduction and types of standards, TPS, DIN and other Quality standards One relevant case study.	07

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	Total	**35**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Dale H.Besterfiled, et al., Total Quality Management, Pearson Education.
2.	TQM, Prof. K. Shridhara Bhat, Himalaya Publishing House.
3.	Lean Six Sigma Using SigmaXL and Minitab by Issa Bass (Author), Barbara Lawton (Author),McGraw Hill Education (India) Private Limited
4.	Feigenbaum.A.V."Total Quality Management, McGrawHill

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 715**
2. Course Title: **QUALITY CONTROL**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: VII** **8.** Subject Area**: DE**
9. Pre-requisite**: Nil**

10. Course Outcomes:

Course Outcome 1: Understand the basic concepts of Quality Control (QC).

Course Outcome 2: Describe, distinguish and use the several techniques and quality management tools.

Course Outcome 3: Explain and distinguish the normalisation, homologation and certification activities.

Course Outcome 4: Identify the elements that are part of the quality measuring process in the industry.

Course Outcome 5: Predict the errors in the measuring process, distinguishing its nature and the root causes.

Course Outcome 6: Understand and calculate the correction and uncertainty parameters as a result of an instrument calibration.

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	Concepts of quality: Quality - Quality control - Quality assurance - Quality management- Quality costs Total Quality Management: Axioms - Management commitment- Deming's approach - Quality council - Customer satisfaction and retention - Employee involvement and empowerment-Suggestion system - Quality circle -Continuous process improvement - Juran's trilogy - PDSA	08

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	cycle - Kaizen - Six-sigma -Crosby's quality treatment	
2.	Management tools and techniques: Benchmarking - ISO quality management systems -Quality function deployment - Quality by design -	**06**
3.	Failure mode and effect analysis -Affinity diagram - Block diagram - Pareto chart - Fish bone diagram - Flow chart - Run chart - Scatter diagram - Tree diagram - Matrix Diagram.	**07**
4.	Statistical tools 1-control charts: Basic concepts - Attributes and variables - Random and assignable causes of variations- Patterns of variation - Measures of central tendency and dispersion - Probability distributions: Binomial, Poisson and Normal Control charts for variables : $\bar{X}$, R and sigma charts - Details of construction and uses Control charts for attributes: p, np, c and u charts - Details of construction and uses (Numerical problems included).	**07**
5.	Statistical tools 2- Acceptance sampling, Reliability and Life testing: Sampling Vs inspection - OC curve - Single and double sampling plans - ATI - AOQL - Life testing - Bathtub curve - MTBF - OC curve for Life testing - System reliability (Numerical problems included).	**07**
	Total	**35**

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Bester Field, Dale H, Carol Boeterfreld - Muchna, Glen H, Boeterfreld MeryBoeterfeld-Scare, 2003, Total Quality Management,3rd edition, Pearson, Education, New Delhi.
2.	Grant.E.L., Stastical Quality Control, McGraw Hill
3.	Juran J.M, Gryna I.M., Quality Planning and Analysis, Tata McGraw Hill Publishing Company
4.	Gerals M Smith- 2004, Statistical Process Control and Quality Improvement- 5th edition

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TME 716**
2. CourseTitle: **COMPUTER INTEGRATED MANUFACTURING**

3. ContactHours: **L:3** **T: 0** **P: 0**

4. ExaminationDuration(Hrs.): **Mid** 1.5 **End** 3

5. RelativeWeightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 3 **7.**Semester**:VII** **8.** Subject Area**:DE**

9.Pre-requisite**: Manufacturing Processes**

10. Course Outcomes:

Course Outcome 1:Understand the basic fundamentals of computer integrated manufacturing.

Course Outcome 2: To understand components of CIM.

Course Outcome 3: To understand computer aided inspection & handling systems.

Course Outcome 4: To understand computer aided planning & control and computer monitoring.

Course Outcome 5: To understand types of production monitoring systems.

Course Outcome 6: To understand manufacturing support systems & apply it for different manufacturing processes

11.Details ofCourse:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION TO CIM** Concept of Computer Integrated Manufacturing (CIM); Basic components of CIM; Distributed database system; distributed communication system, computer networks	08

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	for manufacturing; future automated factory; social and economic factors; concurrent engineering; limitations of CIM.	
2.	**COMPONENTS OF CIM** *M* as a concept and a technology, computerized elements of CIM; CASA/Sme model of CIM, CIM II, benefits of CIM, communication matrix in CIM, fundamentals of computer communication in CIM. *M* data transmission methods - serial, parallel, asynchronous, synchronous, modulation, demo dulation, simplex and duplex. *p*es of communication in CIM - point to point (PTP), star and multiplexing. Computer networking in CIM - the seven layer OSI model, LAN model, MAP model, network topologies - star, ring and bus, advantages of networks in CIM.	**08**
3.	**COMPUTER AIDED INSPECTION AND HANDLING SYSTEMS** Computer Aided Inspection and Quality Control; Non contact inspection; Computer aided testing. Flexible manufacturing systems (FMS) - Types of Flexibility; FMS Components; FMS Application & Benefits. Automated material handling systems (conveyor, automated guided vehicle, pallets etc.); Automated storage and retrieval systems; **.**	**09**
4.	**COMPUTER AIDED PLANNING AND CONTROL AND COMPUTER MONITORING** Production planning and control; Master production schedule; cost planning and control; inventory management; material requirements planning (MRP); shop floor control. Lean and Agile Manufacturing. Types of production monitoring systems; structure model of manufacturing; process control and strategies; direct digital control.	**08**
5.	**MANUFACTURING SUPPORT SYSTEMS:** CAPP and its logical steps, benefits, types, forward and backward planning implementation considerations, process planning systems, CAQC, CMM, JIT principles, the meaning of JIT, MRP-I and MRP-II, ERP, EDM, PDM & PLM, business functions, computer aided forecasting; office automation.	**09**
	Total	**42**

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12.SuggestedBooks:

S. No.	Name of Authors /Books /Publisher
1.	Mikell P. Grover, **Automation, Production Systems and Computer-Integrated Manufacturing,** Pearson Education, New Delhi.
2.	P. Radhakrishnan & S. Subramanyan **CAD/CAM/CIM** Willey Eastern Limited New Delhi.
3.	Hans B. Kief and J. Frederick Waters **Computer Numerical Control,** Glencae Macmillan/McGraw Hill
4.	Steve Krar and Arthar Gill, **CNC Technology and Programming**, McGraw Hill Pub. Company, New Delhi.

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **UCE 701**
2. Course Title : DISASTER MANAGEMENT
3. Contact Hours: **L: 1** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 1 **7.** Semester**: VII** **8.** Subject Area**: General Course**

9.Details of Course:

Unit No.	Contents	Contact Hours
1.	**Understanding Disasters** Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management	02
2.	**Types, Trends, Causes, Consequences and Control of Disasters** Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Man-made Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters	08
3.	**Disaster Management Cycle and Framework**	08

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	Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation – Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR,Yokohama Stretegy, Hyogo Framework of Action	
4.	**Disaster Management in India** Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter-Governmental Agencies	**07**
5.	**Applications of Science and Technology for Disaster Management** Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non Structural Mitigation of Disasters S&T Institutions for Disaster Management in India	**07**
	Total	**32**

12.Suggested Books:

S. No.	Name of Authors /Books /Publisher
1.	Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2.	An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
3.	Management of Natural Disasters in developing countries, H.N. Srivastava & G.D. Gupta, Daya Publishers, Delhi, 2006, 201 pages
4.	Natural Disasters, David Alexander, Kluwer Academic London, 1999, 632 pages

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Lab Code: **PME 717**
2. Course Title: **AUTOMOBILE ENGINEERING LAB**

3. Contact Hours: **L: 0** **T: 0** **P: 3**

4. Examination Duration (Hrs.): **Mid** 3 **End** 3

5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25

6. Credits: 1 **7.** Semester: **VII** **8.** Subject Area: **CC**

9. Pre-requisite: **Automobile Engineering**

10. Course Outcome:

Course Outcome 1: Students will be able to understand about Breaking, Ignition and fuel supply system

Course Outcome 2: Students will be able to understand about gearbox, steering and suspension systems.

Course Outcome 3: Students will be able to understand about cooling, lubrication and lightning systems

Course Outcome 4: Students will be able to understand about Transmission MPFI and fuel injection systems.

11. List of Experiments:

Note: Students are required to perform minimum 12 experiments out of these 14 experiments.

1. Study and demonstration on braking system.
2. Study and demonstration of fuel supply system of S I engine.
3. Study and demonstration of Ignition system.
4. Study and demonstration of steering system.
5. Study and demonstration of gear box of an automobile.
6. Study and demonstration of Suspension system.
7. Study and demonstration of cooling system.

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8. Study and demonstration of lubrication system.
9. Study and demonstration of lightning system.
10. Study and demonstration of fuel supply / injection system of C I engine.
11. Study and demonstration of M.P.F.I system
12. Study and demonstration of universal joint, propeller shaft, differential.
13. Study and demonstration of starting system of car/engine.
14. Study and demonstration dismantling and assembling of wheels and tyres.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 812**

2. Course Title: **NON-CONVENTIONAL ENERGY RESOURCES**

3. Contact Hours: **L: 3** **T: 0** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25

6. Credits: 3 **7.** Semester: **VIII** **8.** Subject Area: **DE**

9. Pre-requisite: **Nil**

10. Course Outcomes:

Course Outcome 1: Describe and understand the energy scenario, Energy consumption, GDP and energy demand at global scale and in India.

Course Outcome 2: Understand and analyze solar radiation available terrestrially and also methods of harnessing solar energy efficiently.

Course Outcome 3: Analyze and describe availability of wind energy at various geographical locations and also methods of harnessing the energy through turbines.

Course Outcome 4: Understand and analyze various other renewable resources, challenges and methods or harnessing the energy.

Course Outcome 5: Describe the hydrogen as an energy source, method of production, storage and transportation and challenges associated with it.

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Course Outcome 6: Energy conservation in residential and industrial locations, energy audit in various thermal components.

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	Indian and global energy sources, Energy exploited Energy planning, Energy consumption and GDP, Energy demand analysis, National energy plan. Introduction to various sources of non-conventional energies.	**07**
2.	Spectral distribution, Solar constant, Solar radiations on earth, Measurement of solar radiations, Solar radiation geometry, flux on a plane surface, latitude, expression for angle between, incident beam and the normal to a plane surface (no derivation), Local apparent time, Apparent motion of sun, Day length. Solar collectors, Flat plat, concentric collectors, cylindrical collectors. Solar energy storage.	**07**
3.	Wind energy: Properties of wind, Availability of wind energy in India, wind Velocity, wind machine fundamentals, Types of wind machines and their characteristics, Horizontal and Vertical axis wind mills, Elementary design principles, Coefficient of performance of a wind mill rotor, Aerodynamic considerations in wind mill design, Selection of a wind mill Geothermal energy: Principal of working, types of geothermal station with schematic representation.	**07**
4.	Tidal power: Tides and waves as sources of energy, Fundamentals of tidal power, Use of tidal energy, Limitations of tidal energy conversion systems. Hydrogen Energy: Properties of hydrogen in respect of its use as source of renewable energy, Sources of hydrogen, Production of hydrogen, Storage and transportation, Problems with hydrogen as fuel.	**07**
5.	Electrical energy conservation in building lighting, heating, ventilating and air-conditioning, power factor improvement in power systems, Energy audit of Combustion process, Boilers, Turbines, compressors, Pumps, Heat exchangers, Condensers, Use of industrial, wastes.	**07**
	Total	**35**

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12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Energy Management and condevtion, by Clive Beggs,Butterwoth- Heinemann Elsevier Science.
2.	Optimising Energy Efficiency in the Industry, By Rajan, Tata Mc Graw Hill Publishers.
3.	Renewable Energy Sources and their Environment Impact, byAbbasi&Abbasi, Prentice Hall of India.
4.	Ashok V. Desai, "Nonconventional Energy", New Age Internantional Publishers Ltd.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 814**

2. Course Title: **ADVANCED WELDING TECHNOLOGY**

3. Contact Hours: **L: 3** **T: 0** **P: 0**

4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3

5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25

6. Credits**:** 3 **7.** Semester**: VII** **8.** Subject Area**: DE**

9. Pre-requisite**:** **Manufacturing Processes**

10. Course Outcomes:

Course Outcome 1: Understand the welding, its process classification and other limitations of the process.

Course Outcome 2: Understand and review brief technologies aspect of conventional welding techniques.

Course Outcome 3: Understand and analyze different advance welding techniques and their applications.

Course Outcome 4: Analyze and understand welding design and metallurgical aspects.

Course Outcome 5: Understand principle and application of arc fusion welding.

Course Outcome 6: Describe different testing and inspection methods of welding joints and their applications.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	Introduction: Definition, Classification, Application, Advantages & limitations of welding, Selection guidelines for relevant welding process, Comparison of welding with other joining methods Brief technological review of conventional welding techniques: Oxy-acetylene gas welding, Introduction to welding torch & filler rod, Principle of arc welding, Inert Gas Welding (MIG and TIG),Submerged arc welding (SAW), Various types of Resistance Welding, Soldering, Brazing techniques and their applications, Types of welding electrodes, Classification and coding of mild steel and low alloy steel electrodes, American system and Indian system, types of fluxes used for fusion welding, soldering and brazing.	**08**
2.	Advanced welding Techniques I:Principle, techniques, problems (limitations), working and applications of advanced welding techniques such as Plasma Arc Welding (Key-hole and non-keyhole techniques), Electro-slag welding, Laser beam welding, Electron beam welding, Ultrasonic welding, Friction stir welding, Explosive welding, Underwater welding, Welding of Plastics and Dissimilar metals , Need and Technology of Cladding, Hard-facing , Surfacing, Oxy-acetylene gas cutting, Electric arc cutting	**08**
3.	Welding Design and Metallurgical Factors: Heat input, net heat utilized in melting, heat flow, relative plate thickness factor, transverse shrinkage, longitudinal shrinkage, Angular distortion, control of distortion, Weldability, Effects of alloying elements on Weldability, Weldability tests such as Hot-cracking test, the Murex test, Cold-cracking or Hydrogen-induced cracking test, Effect of carbon content on structure and properties of steel, Carbon-equivalent and its relation with cooling rate, Carbon-equivalent based statistical evaluation of hot-cracking tendency.	**08**
4.	**Principle of Arc fusion welding:** Electrons thermionic emission, thermionic work function and ionization potential, Cathode spot, cathode space, arc column, anode space and anode spot, Various Modes of Metal Transfer in arc welding, Welding defects, detection, Various causes & remedy, Heat-	**07**

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	affected-zone (HAZ) and its effects on weld properties, Hydrogen embrittlement, Phenomenon of Arc blow, its effects in welding and its control.	
5.	Inspection Methods - Testing and inspection of welding joints, Methods used for Inspection of welding, Hardness test, Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, methods of Inspection. Basic welding symbols and location of weld, Measurement of heat input in arc welding, Heat flow.	**05**
	Total	**36**

12.Suggested Books:

No.	**Name of Authors /Books /Publisher**
1.	O.P. Khanna, A Text Book of Welding Technology, Dhanpat Rai Publications , New Delhi
2.	Dr. Parmar R.S. ,Welding Engineering and technology; Khanna Publisher.
3.	Rao, Manufacturing Technology (Foundary, Forming and Welding), Tata McGraw-Hill Publications, New Delhi.
4.	b Ghosh, Manufacturing Science, Tata McGraw-Hill Publications, New Delhi.

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NAME OF DEPARTMENT: **Department of Mechanical Engineering**

1. Subject Code: **TME 815**
2. Course Title: **TRIBOLOGY**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: VIII** **8.** Subject Area**: DE**
9. Pre-requisite**:** **Mechanics**

10. Course Outcomes:

Course Outcome 1: Understanding of the interdisciplinary subject 'Tribology' and its significance.

Course Outcome 2: Understand the friction and analyse the friction measurement methods.

Course Outcome 3: Describe the consequences of wear, wear mechanisms and analysis of wear problems.

Course Outcome 4: Describe the principles of lubrication and theories of hydrodynamic lubrication.

Course Outcome 5: Analyse the general requirements of bearing and study the classification of bearing.

Course Outcome 6: Analyse the Hydrostatic step bearing and discuss the Petroffs equation.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION** Introduction to Tribology, system and its properties, Viscosity and its variation for different fluids, absolute and kinematic viscosity, temperature variation, viscosity index determination, different viscometers	06
2.	**FRICTION** Role of friction and laws of static friction, theories of friction, Laws of rolling friction, Friction of metals and non-metals, Friction measurements methods.	06
3.	**WEAR** Definition and mechanism of wear, types and measurement of wear, friction affecting wear, Theories of wear, Wear of metals and non-metals. Lubricants, function and properties of lubricants.	06
4.	**HYDROSTATIC LUBRICATION** Principle of hydrostatic lubrication, General requirements of bearing materials, Bearing materials, hydrostatic step bearing, applications to pivoted pad thrust bearing and other applications.	06
5.	**HYDRODYNAMIC LUBRICATION** Principle of hydrodynamic lubrication, Petroffs equation, Reynold's equation in two and three dimensions, Effects of side leakage, Minimum oil film thickness, Oil whip and whirl, Anti-friction bearing, Hydrodynamic thrust bearing. Air/gas lubricated bearing.	08
	Total	32

12.Suggested Books:

S. No.	Name of Authors /Books /Publisher
1.	Fundamentals of Tribology, Basu, SenGupta and Ahuja, PHI
2.	Tribology in Industry: Sushil Kumar Srivatsava, S. Chand &Co.
3.	Tribology - B.C. Majumdar