GraphicEra
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COURSE COMPONENTS OF ACADEMIC PROGRAMME

UNDERGRADUATE PROGRAMME

B.Tech Mechanical Engineering with specialization in

Automobile Engineering

Batch 2017-21

Minimum Duration: 8 Semesters (4 years)

Maximum Duration: 12 Semesters (6 years)

Total number of credits: 213 credits

Course Components

Credits

1. Compulsory courses

i.	Foundation course (FC)	59
ii.	Core course (CC)	109

2. Elective courses

i.	Departmental electives (DE)	9

3. Discipline-Centric Additional Courses

i.	Seminar (SE)	6
ii.	Project (PJ)	10
iii.	Career Skill (CK)	8
iv.	Comprehensive viva	1

4. General courses

i.	Disaster Management	3
ii.	General Proficiency (GP)	8

Requirement of Awards of Degree: - Total Credits - 213; CGPA>=4.5 and any other condition as per regulation and ordinances.

Abbreviations

Foundation Course (FC), Core Course (CC), Elective Departmental (DE), Seminar (SE), Career Skill (CK), Project (PJ), Dissertation (DS), Class work Assessment (CWA), Mid Semester Exam (MSE), End Semester Exam (ESE)

SEMESTER-III

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt./ LR/Att	ESE	Total
	Theory									
1.	TMA303	Engineering Mathematics III	3	1	0	4	25	25	50	100
2.	TME 302	Material Science and Metallurgy	3	1	0	4	25	25	50	100
3.	TME303	Mechanics of Materials	3	1	0	4	25	25	50	100
4.	TME304	Basic Thermodynamics	3	1	0	4	25	25	50	100
5.	TME305	Manufacturing Processes I	3	1	0	4	25	25	50	100
	Labs									
6.	PME 311	Computer Aided Machine Drawing	0	0	6	4	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.	SME301	Seminar	0	0	2	1	-	-	100	100
10.	XCS 301	Career Skills-I	2	1	0	2	25	25	50	100
11.	GP301	General Proficiency	-	-	-	1	-	-	100	100
Total			17	6	14	30	225	225	650	1100

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

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

LR : Lab Record ESE : End Semester Examination

SEMESTER-IV

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt./ LR/ Att	ESE	Total
	Theory									
1.	TME401	Applied Thermodynamics	3	1	0	4	25	25	50	100
2.	TME402	Industrial Engineering	3	1	0	4	25	25	50	100
3.	TME403	Manufacturing Processes II	3	1	0	4	25	25	50	100
4.	TME404	Mechanical Measurements & Metrology	3	1	0	4	25	25	50	100
5.	TME405	Kinematics of Machines	3	1	0	4	25	25	50	100
	Labs									
6.	PME411	Machine Shop	0	0	3	1	25	25	50	100
7.	PME412	Applied Thermodynamics Lab	0	0	3	1	25	25	50	100
8.	PME413	Measurements & Metrology Lab	0	0	3	1	25	25	50	100
9.	SME401	Seminar	0	0	2	1	-	-	100	100
10.	XCS401	Career Skills-II	2	1	0	2	25	25	50	100
11.	GP401	General Proficiency	-	-	-	1	-	-	100	100
Total			17	6	11	27	225	225	650	1100

L : Lecture, T : Tutorials, P : Practicals MT : Midterm Examinations
Att. : Attendance Asmt. : Teachers Assessment as Assignments, Seminar,
LR : Lab Record ESE : End Semester Examination

SEMESTER-V

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt./ LR/ Att	ESE	Total
	Theory									
1.	TME501	Heat and Mass Transfer	3	1	0	4	25	25	50	100
2.	TME502	Design of Machine Elements-I	3	1	0	4	25	25	50	100
3.	TME503	Dynamics of Machines	3	1	0	4	25	25	50	100
4.	TAE504	Automotive Transmission	3	0	0	3	25	25	50	100
5.	TAE505	I C Engines and Gas Turbines	3	1	0	4	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.	PAE513	Automotive Transmission Lab	0	0	3	1	25	25	50	100
9.	SME501	Seminar	0	0	2	1	-	-	100	100
10.	XCS501	Career Skills-III	2	1	-	2	25	25	50	100
11.	GP501	General Proficiency	-	-	-	1	-	-	100	100
			17	5	11	26	225	225	650	1100

L : Lecture, T : Tutorials, P : Practicals MT : Midterm Examinations
Att. : Attendance Asmt. : Teachers Assessment as Assignments, Seminar,
LR : Lab Record ESE : End Semester Examination

SEMESTER-VI

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt./ LR/ Att	ESE	Total
	Theory									
1.	TME601	Refrigeration and 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.	TAE603	Automotive Fuels and Lubricants	3	0	0	3	25	25	50	100
4.	TAE604	Automobile Engineering	3	0	0	3	25	25	50	100
5.		Elective I	3	0	0	3	25	25	50	100
	Labs									
6.	PME611	Refrigeration & Air Conditioning Lab.	0	0	3	1	25	25	50	100
7	PME612	Design Lab	0	0	3	1	25	25	50	100
8.	PAE613	Automobile Engineering lab	0	0	3	1	25	25	50	100
9.	MEP601	Mini Project	-	-	-	2	-	-	100	100
10.	XCS601	Career Skills-IV	2	1	-	2	25	25	50	100
11.	GP601	General Proficiency	-	-	-	1	-	-	100	100
Total			17	3	9	25	225	225	650	1100

Elective I

Code	Elective name
TME 611	Finite Element Method
TME 612	Quality control
TME 613	Total Quality Management

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

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

LR : Lab Record ESE : End Semester Examination

SEMESTER-VII

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt. / LR/Att	ESE	Total
	Theory									
1.	TME701	Mechanical Vibrations	3	0	0	3	25	25	50	100
2.	TME702	CAD/CAM	3	1	0	4	25	25	50	100
3.	TAE701	Vehicle Transport Management	3	0	0	3	25	25	50	100
4.	TAE704	Hydraulic & Pneumatic Systems	3	0	0	3	25	25	50	100
5.		Elective-II	3	0	0	3	25	25	50	100
	Labs									
6.	PME711	Automation & CNC Lab	0	0	3	1	25	25	50	100
7.	PAE712	Hydraulic & Pneumatic Systems Lab	0	0	3	1	25	25	50	100
8.	PME713	Seminar on Industrial Interaction*	-	-	-	1	--	--	100	100
9.	MEP701	Project work Phase I	-	-	-	2	--	--	100	100
10.	GP701	General Proficiency	-	-	-	1	-	-	100	100
Total			15	1	6	22	175	175	650	1000

***Compulsory Industrial Training of four to six weeks**

Elective II

Code	Elective name
TAE 711	Quality Engineering and Management
TAE 712	Optimization for Engineering Design
TAE 713	Tribology

L : Lecture, T : Tutorials, P : Practicals MT : Midterm Examinations
Att. : Attendance Asmt. : Teachers Assessment as Assignments, Seminar,
LR : Lab Record ESE : End Semester Examination

SEMESTER-VIII

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt. / LR/Att	ESE	Total
	Theory									
1.	TAE801	Automotive Engine Pollution and Control	3	0	0	3	25	25	50	100
2.	TME802	Power plant Engineering	3	1	0	4	25	25	50	100
3.		Elective III	3	0	0	3	25	25	50	100
4.	UCE801	Disaster Management	3	0	0	3	25	25	50	100
	Labs									
5.	TAE811	Automotive Engine and Chassis Components Lab	0	0	3	1	25	25	50	100
6.	MEP801	Project work Phase II	-	-	-	6	--	100	150	250
7	GP801	General Proficiency	-	-	-	1	-	-	100	100
Total			12	1	3	21	125	225	500	850

Electives-III

Code	Elective Name
TAE 821	Vehicle Body Engineering and Safety
TAE 822	Automobile Aerodynamics
TAE 823	Automotive Electricals and Autotronics

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

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

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

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

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

6. Credits**:** **4** **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.

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	tructure 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.	lastic 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.	hase 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.	ngineering 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.	Material 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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 303**
2. Course Title: **MECHANICS OF MATERIALS**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

6. Credits**: 4** **7.** Semester**: III** **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.

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 (including compound bars). Compound stresses: Introduction, 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.	**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). Elastic stability of columns: Introduction 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	**10**
	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.	**Mechanics 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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 304**
2. Course Title: **BASIC THERMODYNAMICS**

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

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

Course Outcome 2: Understand and analyze the zeroth, first and second laws of thermodynamics and the Carnot cycle.

Course Outcome 3 Evaluate the laws of thermodynamics as applied to engineering problems.

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

Course Outcome 5 : Understand and analyze the properties of pure substances.

Course Outcome 6: Understand and analyze the behavior of real gases and the thermodynamic relations.

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	Thermodynamics Introduction: Definition & scope, Macroscopic Vs Microscopic approaches. Thermodynamic System & Control volume. Thermodynamic Equilibrium; state of a system, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes. Work Transfer, Different modes of work, Path and Point Functions, Indicator Diagram, Heat Transfer, Specific and Latent Heats. **Zeroth law of thermodynamics:** Concept of Temperature and its measurement, Temperature scales. **First law of thermodynamics**: Thermodynamic definition of work, Displacement work and flow work, , Displacement work for various non flow processes, Joules' experiment, First law analysis for closed system (non flow processes), Internal energy and enthalpy. Limitations of first law of thermodynamics, PMM-I.	**08**
2.	First Law Application to flow processes, state-steady flow energy equation, important applications and examples of steady flow processes, analysis of unsteady processes such as Charging and discharging a tank with and without heat transfer. Second Law of Thermodynamics: Qualitative Difference between heat and work, ermal Energy Reservoirs. Kelvin -Planck statement & Clausius statement, Refrigerator and Heat pump. Equivalence of the two statements; Reversibility and irreversibility, Causes of Irreversibility, Carnot cycle, Carnot's Theorem & its Corollary Absolute Thermodynamic temperature scale. Reversible heat engines, Efficiency, Equality of Ideal Gas Temperature & Kelvin Temperature.	**08**
3.	Entropy: Clausius' Theorem, The Property of Entropy, T-S Plot, Clausius inequality; Entropy Change in an Irreversible Process, Entropy Principle & It's applications. Entropy Generation in a closed and Open System, Directional Nature of Second law, Entropy and Disorder. vailability and Irreversibility: - Available Energy, Quality of Energy, Law of Degradation of Energy, Maximum Work, maximum useful work for a system and a control volume, Energy, Dead State, availability of a system and a steadily flowing stream, irreversibility, Second law efficiency.	**08**
4.	Pure substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapour states of a pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness factor (quality), T-S and h-s diagrams, representation of various processes on these diagrams. Steam tables, mollier chart (use in numerical). Throttling calorimeter, separating and throttling calorimeter	**08**
5.	Real and ideal gases: Introduction; Vander Waal's Equation Van der Waal's constants in terms of critical properties, law of corresponding states, compressibility factor; compressibility)" chart. Universal and particular gas constants, specific heats. Ideal gas mixture; Dalton's law of additive pressures,	**08**

	Amagat's law of additive volumes, evaluation of properties. Analysis of various processes. **Thermodynamic relations** : Mathematical Theorems, Maxwell's Equations, TdS Equations, Difference in Heat Capacities, Ratio of Heat Capacities, Energy Equations, Joule-Kelvin Effect, Clausius-Clapeyron Equation, Gibbs Phase Rule, Joule-Thomson coefficient.	
	Total	**40**

12. Suggested Books:

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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 305**
2. Course Title: **MA N U F A C T U R I N G PROCESSES – I**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **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**.**

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

11. Details of Course:

Unit 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, Core. Solidification of Castings, Types of casting process, Defects in Casting, their causes& remedies	**08**
2.	Forging: 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.	Rolling: 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**

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

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**

3. Contact Hours: **L: 0** **T: 0** **P: 6**

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

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

6. Credits**: 4** **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: PART A

Unit No.	Contents	Contact Hours
1.	**Sections of Solids:** Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids). True shape of sections. thographic 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
2.	**Thread forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. **Fasteners**: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.	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.	08
4.	**Couplings:** Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)	08
	Total	32

PART: B

Assembly Drawings (Part drawings should be given)

1. Screw jack (Bottle type)
2. Plummer block (Pedestal Bearing)
3. Machine vice
4. Tailstock of lathe
5. I.C. Engine connecting rod
6. Tool Head of a shaper

30 Hours

Software Used:

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

12. Suggested Books:

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

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**

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

4. Examination Duration (Hrs.): **3** **Mid** **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.
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 specimen for micro structural examination using cutting, grinding, polishing and etching.
14. To make a plastic mould for small metallic specimen by moulding press.

INNOVATIVE EXPERIMENT

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

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**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **3** **Mid** **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.

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

Innovative experiments

15. Comparative study of oil fired furnace and pit furnace by fabrication of a hook nail of required dimension.
16. 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 401**
2. Course Title: **APPLIED THERMODYNAMICS**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

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

10. Course Outcome:

Course Outcome 1: Understand and apply the laws of thermodynamics to various gas power cycles.
Course Outcome 2: Understand and apply the laws of thermodynamics to gas turbine.
Course Outcome 3: Understand, analyze and apply the laws of thermodynamics to jet propulsion system.
Course Outcome 4: Understand and apply the laws of thermodynamics to vapour power cycle.
Course Outcome 5: Understand and apply the laws of thermodynamics to compressors.
Course Outcome 6: Understand the concept of psychrometics and apply it to air condition systems.

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	**GAS POWER CYCLES:** Air standard cycles; assumptions in the analysis of Air standard cycles, Carnot, Otto, Diesel, and Dual, P-v and T-s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto, Diesel and Dual cycles – (problems). 'ling cycle, Lenoir cycle, Atkinson cycle and Ericsson cycle - (description on P-v and T-s diagrams only).	**08**
2.	**GAS TURBINES AND JET PROPULSION:** Classification of Gas Turbines, Analysis of open cycle gas turbine cycle. Advantages and Disadvantages of closed cycle. Efficiencies and effect of pressure ratio - (problems), Methods to improve thermal efficiency, Reheating and intercooling in Brayton cycle (problems). propulsion, turbojet engines - merits and demerits, turbo propeller engines – merits and demerits, ramjet– merits and demerits, Rocket propulsion – applications of rockets (No Numerical).	**08**
3.	**VAPOUR POWER CYCLE:** -Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T - s diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles - (problems), Reheat Rankine cycle, Ideal regenerative Rankine cycles, open and closed feed water heaters.	**09**
4.	**COMPRESSORS:** - Air Compressors-uses of compressed air – classifications of Air compressor, reciprocating compressor, single stage reciprocating compressor, compression processes, power required to drive the compressor - Neglecting clearance Volume, (problems), clearance volume and its effects – volumetric efficiency, power required to drive the compressor with clearance volume – (problems), multi stage compression –merits and demerits – multi stage compressor with perfect inter cooling - work input – condition for minimum work input– (problems). Rotary compressors, screw and scroll compressors, Roots blower, vane blowers, centrifugal and axial flow air compressors - Applications. (Description only - no numerical).	**08**
5.	**PSYCHROMETRICS:** - Atmospheric air and psychrometric properties; Dry bulb temperature, wet bulb temperature, dew point temperature; partial pressures, specific and relative humidifies and the relation between the two Enthalpy and adiabatic saturation temperature. Construction and Use of psychrometric chart. Analysis of various processes; heating, cooling, dehumidifying and humidifying. Adiabatic mixing of stream of moist air - (problems).	**08**
	Total	**41**

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. Co.
2.	Basic and Applied Thermodynamics by P.K.Nag, Tata McGraw Hill Pub. Co.
3.	**Thermal Engineering** by Mahesh M. Rathore Tata McGraw-Hill Education
4.	Fundamental of Classical Thermodynamics by G.J. Van Wylen and R.E.Sonntag, Wiley Eastern.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 402**
2. Course Title: **INDUSTRIAL ENGINEEING**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): 1.5 **Mid** 3 **End**
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: 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.

11. Details of Course:

Unit 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, Advantages of good facility layout, Factors effecting plant location, selection of plant site, Design of work places, influence of climate on human efficiency. Influence of noise, vibration and light.	**08**
2.	**WORK STUDY:** definition, objective & scope of work study, human factors in work study, work study & management, work study & supervisor, work study & worker. **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. Work Measurement: Definition, objectives, techniques of work measurement, work sampling, need of confidence levels, sample size determination, random observation with simple problems.	**08**
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. **MATERIALS MANAGEMENT:** Objectives and functions, Purchasing function, Purchasing procedure, Inspection & QC, Make or buy decisions, simple break even analysis, Break even point theory, Obsolete, Scrap & surplus management, Inventory Control, Need of inventory control, types of inventory, inventory costs, inventory control models, determination of EOQ (under deterministic conditions), safety stock inventory control model.	**08**
4.	**INTRODUCTION TO INDUSTRIAL DESIGN:** elements of design structure for industrial design in engineering application in modern manufacturing systems. **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.	**08**
5.	**FORECASTING:** Types of forecasting, measuring forecast error, Quantitative methods of forecasting, Time series analysis. (Numerical). **ESTIMATING & 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.	**08**
	Total	**40**

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

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**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

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.

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.	**Theory of Metal Cutting**: 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.	**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.	**Welding 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.	**Unconventional 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**

12. Suggested Books:

No.	Name of Authors /Books /Publisher
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.
4.	**Fundamentals of Metal Machining and Machine Tools** by G. Boothroyd, McGraw Hill.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 404**
2. Course Title: **MECHANICAL MEASUREMENTS AND METROLOGY**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

4 **6.** Credits**:** **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 (Numericals), 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 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.	**09**
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, Sine Principle and. use of Sine bars, Sine center, use of angle gauges, (numericals on building of angles) Clinometers. Terminology of screw threads, measurement of major, minor pitch, angle and effective diameter of screw threads, 2-wire and 3-wire methods, Toolmakers microscope, gear terminology, use of gear tooth Vernier calliper and gear tooth micrometer. Principle of interferometery, autocollimator, optical flats.	**09**
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, Transducers, Mechanical systems, inherent problems, Electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers and telemetry. Terminating devices: Mechanical, Cathode Ray Oscilloscope, Oscillographs, X-Y Plotters.	**09**
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 .	**09**
	Total	**42**

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**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

9. Pre-requisite**: Nil**

10. Course Outcome:

Course Outcome 1: Understand about kinematics of machine, links, pairs, joints, mechanisms, machines, their DOF and inversions related to various kinematic chain.

Course Outcome 2: Understand construction and design of various mechanism.

Course Outcome 3: Analyses velocity and acceleration of various mechanisms through graphical and analytical approach.

Course Outcome 4: Apply the concept of velocity and acceleration analysis through Instantaneous Centre approach and to discuss Klein's Construction for Slider Crank Mechanism.

Course Outcome 5: Characterize gears and kinematic properties of Gear Train.

Course Outcome 6: Understand the concept of Cams and Followers, its motions and construction of the cam profile.

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.	ECHANISMS: 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, Ackerman steering gear mechanism.	**08**
3.	ELOCITY 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.	UR 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.

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.): **3** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **PSM** **25**

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

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.
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.

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PME 412**
2. Course Title: **APPLIED THERMODYNAMICS LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **3** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **PSM** **25**

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

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

10. Course Outcome:

I. Demonstrate understanding of the nature and operating principles of systems involving energy flows.
II. Describe and apply basic thermodynamic principles and laws to analyze and predict the performance of thermodynamic systems.
III. Relate idealized thermodynamic system models to corresponding real systems.

11. List of Experiments:

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

1. Study of Fire Tube boiler.
2. Study of Water Tube boiler.
3. Study of Steam Engine model.
4. Study and working of Four Stroke Petrol Engine.
5. Study & working of Four Stroke Diesel Engine.
6. Study and working of Two Stroke Petrol Engine.
7. Study & working of Two Stroke Diesel Engine.
8. Study & working of Refrigerator.
9. Study & working of Air Conditioner.
10. Performance test on two stage Reciprocating Compressor.
11. To determine the efficiency of a multi cylinder petrol engine by Morse Test.
12. Prepare the energy balance for Diesel/Petrol Engine.
13. Study the efficiency of four stroke petrol engine using compressed air.
14. Study the efficiency of four stroke diesel engine using compressed air.

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.): **3** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **PSM** **25**

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

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

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)

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 501 (Revised in 2019)**
2. Course Title: **HEAT AND MASS TRANSFER**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **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.

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. **ANSIENT 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**
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

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**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

4 **6.** Credits**:** **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.

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:

S. 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 in 2019)**
2. Course Title: **DYNAMICS OF MACHINES**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **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.

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Static 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.	**Dynamic 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.	**Governors 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: **TAE 504**
2. Course Title: **AUTOMOTIVE TRANSMISSION**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

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

10. Course Outcomes:

Course Outcome 1: Understand the construction and operation of automobile clutches.
Course Outcome 2: Describe the different types of gear box along with their applications.
Course Outcome 3: Explain the construction and operation of hydrodynamic drives.
Course Outcome 4: Explain the construction and operation of hydrostatics drives.
Course Outcome 5: Describe the constructional details and operational functions of automatic drives.
Course Outcome 6: Describe the constructional details of electric drives and analyze their merits and demerits.

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Clutches:** Necessity of clutch in an automobile, different types of clutches, friction clutches, cone clutches, single plate clutch, diaphragm clutch, multi-plate clutch, centrifugal clutches, electromagnetic clutches, clutch facing materials, clutch adjustments, over running clutches, necessity and field of application, locking devices.	09
2.	**GearBox:** Need for a gear box, types of gear transmission, number of gear ratios, 3 speed and 4 speed transmission , performance curves in different gears, sliding mesh, constant-mesh, synchromesh gearbox, gear materials. Epicyclic transmission: Types of planetary transmission, Ford-Tmodel, Wilson planetary transmission, pre-selective mechanisms, overdrives.	11

3.	**Hydrodynamic Drive:** Advantages and limitations, fluid flywheel-constructional details, working, merits and demerits, anti-dragbaffle, slipperformance characteristics. Constructional details of typical torque converters **Hydrostatic drives**: Advantages and limitations, principles of hydrostatic drive systems: construction and working of typical drives.	**10**
4.	**Automatic Transmission:** General description of working of typical automatic transmission and their control system, comparison with conventional transmission	**07**
5.	**Electric drives**: General arrangement sand description of electric transmission, their working principle and control, advantages and limitations.	**05**
	Total	**42**

12. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	GanesanV.,InternalCombustionEngines,TataMcGrawHill
2.	GanesanV.,GasTurbines,TataMcGrawHill
3.	CrouseandAnglin:Automaticmechanics,McGrawHillPublication
4.	HerbanSinghRoyath:TheAutomobile,S.ChandandCo.Ltd.,Delhi

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 505**
2. Course Title: **IC ENGINES AND GAS TURBINES**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

Area**: CC** **4** **6.** Credits**:** **7.** Semester**: V8.** Subject

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

10. Course Outcomes:

Course Outcome 1: Understand the terminology, concepts and operating cycles of IC engines.
Course Outcome 2: Explain the theory of combustion in CI engines.
Course Outcome 3: Explain the theory of combustion in SI engines.
Course Outcome 4: Analyze the components of a gas turbine plants.
Course Outcome 5: Describe the process of measurement, testing, emission and control of IC engines and their relation to performance evaluation.
Course Outcome 6: Analyze the sub systems of IC engine.

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Introduction of Engines:** Engine classification, four-stroke and two-stroke, spark ignition and compression ignition, Engine performance parameters, Air-standard cycles-Otto, Diesel, Duel, Atkinson and Brayton Cycles, Fuel-air cycle, effect of gas dissociation, variable specific heats , Actual cycles, heat losses factor, time loss factor, exhaust blow–down factor, scavenging–objectives, effects and methods.	**10**

2.	**Combustion in SI Engines**- Flame propagation, normal and abnormal combustion, detonation, pre-ignition, after burning, fuel rating, Octane number, additives in petrol, combustion chambers of SI engines. **Combustion in CI Engines**- Phase of normal combustion, diesel knock, effect of engine variables on diesel knock, Cetane number, additives in diesel, combustion chambers of CI engines.	**08**
3.	**Gas Turbine Plants**- Open and closed cycles, thermodynamic cycles, regeneration, reheating, inter-cooling, efficiency and performance of gas turbines, rotary compressors, analysis, centrifugal and axial flow compressors, combustion chambers of gas turbines, cylindrical, annular and industrial type combustion chamber, combustion efficiency, axial flow turbines, elementary and vortex theories, design of nozzles and blades for turbines, limiting factors in turbines design.	**08**
4.	**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, Engine testing, performance and characteristics of constant speed and variable speed engines, heat balance test, Morse test, retardation test. **IC Engine Emission and their Control:** Introduction, SI and CI engines exhaust emissions, Hydrocarbon Emission, CO Emission, NO_x Emission, Particulates, Emission and Control Methods.	**08**
5.	**Systems and Components of IC Engines**- Fuel-systems, ignition systems, cooling, starting, lubrication, governing of IC engine's supercharging of SI and CI engines, turbo charging, exhaust emissions of IC engines, alternate potential engines, free piston engine, Wankel engine and stratified charged engine.	**06**
	Total	**40**

12. Suggested Books:

No.	**Name of Authors /Books /Publisher**
1.	Ganesan V., Internal Combustion Engines, Tata Mc Graw Hill
2.	R. Yadav, Applied thermodynamics and Heat Engines
3.	Willard W. Pullkrabek, Engineering Fundamentals of I C Engines, Spinger

4.	Jerald A. Caton, An introduction to thermodynamic Cycle Simulations for Internal Combustion Engines, Wiley

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PME 511 (Revised in 2019)**
2. Course Title: **HEAT & MASS TRANSFER LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **3** **Mid** **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.

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 in 2019)**
2. Course Title: **DYNAMICS OF MACHINES LAB**

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

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

11. List of Experiments:

Note: Students are required to perform minimum 14 experiments out of these 16 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: **PAE 513**
2. Course Title: **AUTOMOTIVE TRANSMISSION LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **3** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **PSM** **25**

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

9. Pre-requisite**: Automotive Transmission**

10. Course Outcome:

Course Outcome 1: Demonstrate the parts and operation of different gear boxe.
Course Outcome 2: Demonstrate the constructional features and working of different transmission.
Course Outcome 3: Demonstrate the components and assembly of automotive clutches.
Course Outcome 4: Demonstrate the construction and working of automobile joints, transfer case and shafts.

11. List of Experiments:

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

1. Study and demonstration of transmission system for a rear four wheel drive arrangement.
2. Study and demonstration of gears and shafts in a manual sliding mesh type gear-box.
3. Study and demonstration of a two wheel vehicle gear box.
4. Study and demonstration of an automotive constant mesh gear-box.
5. Study and demonstration of an electric drive vehicle.
6. Study and demonstration of differential and rear axle arrangement.
7. Study and demonstration of a two wheel vehicle clutch system
8. Study and demonstration of a four wheel vehicle clutch system.
9. Study and demonstration of gear shifting control of an automatic gear-box.
10. Study and demonstration of a manual transfer case.
11. To study about the Continuous Variable Transmission (CVT) in Automotive Transmission.
12. To study the Propeller shaft and Universal Joint.
13. To study the types of gear and shafts in an Automotive manual type gear box and a transaxle.
14. To study the synchromesh gearbox and Sequential Gearbox arrangement.

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.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

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.

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**

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.

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 602**
2. Course Title: **DESIGN OF MACHINE ELEMENTS II**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

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.

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.	08

	roduction to Torsion, Belleville and Rubber springs	
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. **ain & rope drives:** Introduction.	**08**
3.	**UR AND HELICAL GEARS** finitions, 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**

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: **TAE 603**
2. Course Title: **AUTOMOTIVE FUELS AND LUBRICANTS**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

9. Pre-requisite**: I C Engine**

10. Course Outcomes:

Course Outcome 1: Describe the composition and physical properties of different automotive fuels.

Course Outcome 2: Evaluate the chemical characteristics of fuel.

Course Outcome 3: Describe the combustion characteristics of fuels.

Course Outcome 4: Explain the principle of selection of alternate fuels and compare their performance.

Course Outcome 5: Explain the principles of selection of lubricants and compare their suitability for use.

Course Outcome 6: Analyze the theory of lubrication.

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Manufacture of Fuels and Lubricants and their properties** Structure of petroleum, Refining processes, Classification of petroleum fuels, Thermal cracking, Catalytic cracking, Polymerization, Alkylation, Isomerisation, Blending, Products of refining process. Manufacture of lubricating oil base stocks, Manufacture of finished automotive lubricants. Properties and testing of fuels & Lubricants, relative density, calorific value, fire point, distillation, vapour pressure, flash point, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index. API gravity, aniline point.	10

2.	**Combustion** Chemistry of SI engine combustion, Normal and Abnormal combustion, Knocking, Octane rating. Basic of diesel engine combustion, Diesel knock, Cetane rating, Fuel requirements. Additive, Requirements of an additive, Petrol fuel additives and Diesel fuel additives.	**10**
3.	**Alternate Fuels** Use of alternate fuel in engines, Need for alternate fuels, availability & their properties, general use of alcohols. LPG, CNG, LNG, Hydrogen, Ammonia, Vegetable oils, Bio-diesel & Biogas. Merits & demerits of alternate fuels. Introduction to alternate energy sources like electric vehicle, hybrid vehicle, fuel cell & solar cars.	**08**
4.	**Lubricants** Lubricant, Classification of lubricant, Classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, Properties of grease, Specific requirements for automotive lubricants, oxidation, deterioration and degradation of lubricants, additives, synthetic lubricants.	**08**
5.	**Theory of Lubricants** Engine friction, total engine friction, effect of engine variables on friction, Modes of lubrication, hydrodynamic lubrication, Hydrostatic lubrication, Elasto hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system.	**08**
	Total	**44**

11. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Internal Combustion Engineering by Ganesan V. TaU McGraw -Hill Publishing Co. New, Delhi.
2.	Lubrication. Raymond G. Gunther, Chipton Book Co
3.	Fuels - Solids. Liquids. Gaseous by Brame. J.S.S. and King. I .G.
4.	Fuels and Fuel Technology by Francis, W, Vol. I & II

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 604**
2. Course Title: **AUTOMOBILE ENGINEERING**
3. Contact Hours: **L: 3 T: 0 P: 0**
4. Examination Duration (Hrs.): **Mid End**
5. Relative Weightage**: MSE ESE TSM**
6. Credits**:** **7.** Semester**: VIII** **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 1: Students will be able to understand about engine auxiliary systems
Course Outcome 1: Students will be able to understand about transmission systems
Course Outcome 1: Students will be able to understand about steering, brakes systems
Course Outcome 1: Students will be able to understand about suspension systems.
Course Outcome 1: 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**

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:

S. 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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 611**
2. Course Title: **FINITE ELEMENT METHOD**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

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

10. Course Outcomes:

Course Outcome 1: Understand the basic concepts, mathematical formulation and numerical implementation.

Course Outcome 2: Develop the element stiffness matrices using different approach.

Course Outcome 3: Apply the procedure involved to solve a problem using FEM.

Course Outcome 4: Analyze a 2D problem using different types of elements.

Course Outcome 5: Solve problems using the available commercial package to build Finite Element models and solve a selected range of engineering problems.

Course Outcome 6: Appreciate the importance of ethical issues pertaining to the effective utilization of FEA.

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**
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.

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 612**
2. Course Title: **QUALITY CONTROL (Revised in 2019)**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

6. Credits**: 3** **7.** Semester**: VI** **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 - Suggestion system - Quality circle -Continuous process improvement - Juran's trilogy - PDSA cycle - Kaizen - Six-sigma - Crosby's quality treatment	**08**
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 : 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), Taguchi method	**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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 613**
2. Course Title: **TOTAL QUALITY MANAGEMENT (Revised in 2019)**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

6. Credits**: 3** **7.** Semester**: VI** **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.

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION:** Definition 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:** Quality 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:** e 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 maintenance, Total Productive Maintenance (TPM) , FMEA - Stages of FMEA. One relevant case study using free software for QFD an FMEA, Poka-Yoke.	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
	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

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PME 611**
2. Course Title: **REFRIGERATION & AIR-CONDITIONING LAB (Revised in 2019)**

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

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

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

6. 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.

11. List of Experiments:

Note: Students are required to perform minimum 12 experiments out of these 14 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.
6. Study and performance of window type air conditioning system.
7. Study of all-weather year - round air conditioning system.
8. Study of defrosting in refrigeration.
9. Study of evaporator and condenser.
10. To study the cut sectional model of reciprocating, rotary and centrifugal compressor.
11. To study the various controls used in Refrigeration and Air conditioning system.
12. To study different psychometric process & chart.
13. To Study working principle of steam jet refrigeration system.
14. To Study and performance of VRF air conditioning systems.
15. To study and design of under floor air distribution (UFAD).

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PME 612**
2. Course Title: **DESIGN 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**: VI** **8.** Subject Area**: CC**

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

10. Course Outcome:

Course Outcome 1: Describe and apply the use of standard practices, standard data and standard catalogues.

Course Outcome 2: Discuss the various steps involved in the design process and the principles involved in designing a machine component to satisfy strength requirements.

Course Outcome 3: Analyze stresses developed, failure and an appropriate failure model and design a particular sub set of machine elements for a given problem.

Course Outcome 4: Apply the mechanical software to analyze the mechanical component design problem.

11. List of Experiments:

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

1. Design of Helical Compression Spring and its MATLAB coding
2. Design of transmission shaft for strength under dynamic loading and its MATLAB coding
3. Design of flat belt and its MATLAB coding
4. Design of V-belt and its MATLAB coding
5. Design of Screw Jack
6. Modelling of Screw Jack using CREO
7. Design of Helical Gear drive and its MATLAB coding
8. Modelling of Helical Gear using CREO
9. Design of Bevel Gear drive and its MATLAB coding
10. Design of Worm Gear drive and its MATLAB coding
11. Design of sliding contact bearing and its MATLAB coding
12. Design and selection of rolling contact bearing and its MATLAB coding
13. Design of boiler riveted joint.
14. Design of Coupling Joint.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PAE 613**
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 ESE PSM**
6. Credits**:** **7.** Semester**: VIII** **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.

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 701**
2. Course Title: **MECHANICAL VIBRATIONS (Revised in 2019)**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

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 motions, Fourier Series (Problems), Elements of a Mechanical Vibratory System ,Classification of Vibrations.	**10**
2.	Undamped Free Vibrations - (For Single Degree Of Freedom System: Introduction to undamped free vibration system, , Derivation of differential	**08**

	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.	
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**

12. Suggested Books:

S. 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 702**
2. Course Title: **COMPUTER AIDED DESIGN AND MANUFACTURING (Revised in 2019)**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

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

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.	C 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**

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: **TAE 701**
2. Course Title: **VEHICLE TRANSPORT MANAGEMENT**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

9. Pre-requisite**: Nil**

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	**ORGANISATION AND MANAGEMENT** Forms of Ownership – principle of Transport Management – Staff administration – Recruitment and Training –welfare – health and safety. Basic principles of supervising. Organizing time and people. Driver and mechanic hiring - Driver checklist - Lists for driver and mechanic - Trip leasing - Vehicle operation and types of operations.	**09**
2.	**VEHICLE MAINTENACE** Scheduled and unscheduled maintenance - Planning and scope - Evaluation of PMI programme – Work scheduling - Overtime - Breakdown analysis - Control of repair backlogs - Cost of options.	**08**
3.	**VEHICLE PARTS, SUPPLY MANAGEMENT AND BUDGET** Cost of inventory - Balancing inventory cost against downtime - Parts control - Bin tag systems – Time management - Time record keeping - Budget activity - Capital expenditures - Classification of vehicle expenses - Fleet management and data processing - Data processing systems - Software. Model - Computer controlling of fleet activity - Energy management.	**09**

4.	**SCHEDULING AND FARE STRUCTURE** Route planning - Scheduling of transport vehicles - Preparation of timetable – preparation of vehicle and crew schedule - Costs, fare structure – Fare concessions - Methods of fare collection - Preparation of fare table.	**08**
5.	**MOTOR VEHICLE ACT** Schedules and sections - Registration of motor vehicles - Licensing of drivers and conductors - Control of permits - Limits of speed - traffic signs - Constructional regulations - Description of goods carrier, delivery van, tanker, tipper, municipal, fire fighting and break down service vehicle	**09**
	Total	**41**

11. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	John Dolu, Fleet Management, McGraw-Hill Co.
2.	Goverment Publication, The Motor vehicle Act
3.	Rex W Faulks, Bus and Coach Operation, Butterworth
4.	Kitchin.L.D., Bus operation, 3rd Edition, llliffe and Sons Ltd., London

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 704**
2. Course Title: **HYDRAULIC & PNEUMATIC SYSTEMS**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

9. Pre-requisite**: Nil**

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	**BASIC CONCEPT & PROPERTIES** id - definition, distinction between solid and fluid - Units and dimensions - Properties of fluids -density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressure measurements by manometers and pressure gauges.	**08**
2.	**FLUID KINEMATICS AND FLUID DYNAMICS** id Kinematics - Flow visualization - lines of flow - types of flow -velocity field and acceleration - continuity equation (one and three dimensional differential forms)- Equation of streamline – stream function - velocity potential function - circulation - flow net. Equations of motion- Euler's equation along a streamline - Bernoulli's equation - applications - venturi meter. Orifice meter, other flow measurement instruments, Pilot Tube.	**09**
3.	**DIMENSIONAL ANALYSIS** Dimensional numbers, their application. - Buckingham's theorem - applications - similarity laws and models.	**08**
4.	**INCOMPRESSIBLE FLUID FLOW** Viscous flow-Navier- Stroke's equation (Statement only) - Shear stress, pressure gradient relationship laminar flow between parallel plates - Laminar	**09**

	flow through circular tubes (Hagen poiseulle's) – Hydraulic and energy gradient - flow through pipes - Darcy - weisback's equation - pipe roughness - friction factor - Mody's diagram - minor losses - flow through pipes in series and in parallel – power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.	
5.	**HYDRAULIC TURBINES HYDRAULIC PUMPS, COMPRESSOR & FA** pact of jet on flat, curved & moving plates -Fluid machines: definition and classification exchange of energy - Euler's equation for turbo machines - Construction of velocity vector diagram's - bead and specific work - component of energy transfer - degree of reaction. Pumps: definition and classifications - Centrifugal pump: classifications, working principles, velocity triangles, specific speed, efficiency and performance curves - reciprocating pump: classification, working principles, indicator diagram, work saved by air vessels and performance curves - cavitations in pumps rotary pumps: working principles of gear , vane pumps and peristaltic pumps. Definition - Classification difference, efficiency, and performance curves special application in Auto mobile Industries. .	**09**
	Total	**43**

11. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Fluid Mechanics and Hydraulics Machines (5th edition) by Bansal, R.K, Laxmi Publications (P) Ltd., New Delhi, 1995.
2.	**Fundamentals of Fluid Mechanics, 7th Edition** Bruce R. Munson, Alric P. Rothmayer, Theodore H. Okiishi, Wade W. Huebsch, Wiley Pub
3.	Fluid Mechanics: Fundamentals and Applications by John Cimbala and Yunus A. Cengel, McGrawhill
4.	Fluid Mechanics by White, E M., Tata McGraw-Hill, 5* Edition, New Delhi, 2003

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 711**
2. Course Title: **QUALITY ENGINEERING AND MANAGEMENT**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **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. Details of Course:

Unit No.	Contents	Contact Hours
1.	**I** Concepts of quality: Quality –Quality assurance – Quality management- Total Quality Management and Benefits of TQM: 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 cycle – Kaizen – Six-sigma – Crosby's quality treatment	**08**
2.	Quality control – Introduction to Quality Control: Basic 7 tools of quality control - New 7 Quality control tools - Affinity diagram – Block diagram – Pareto chart – Fish bone diagram – Flow chart – Run chart – Scatter diagram – Tree diagram – Matrix Diagram, , Perceived quality, Aspects of quality, cost of quality.	**08**
3.	Management tools and techniques: Benchmarking – ISO quality management systems – Quality function deployment – Quality by design – Failure mode and effect analysis. Reliability and Maintenance: Definition - Reliability measurement - breakdown maintenance - prevention maintenance - Total productive maintenance - Overall Equipment Effectiveness and Availability.	**08**
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,	**08**

	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).	
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).	**08**
	Total	**40**

11. Suggested Books:

No.	**Name of Authors /Books /Publisher**
1.	Bester Field, Dale H, Carol Boeterfreld – Muchna, Glen H, Boeterfreld Mery Boeterfeld-Scare, 2003, Total Quality Management, 3rd edition, Pearson, Education, New Delhi.
2.	Logethetis, N. (1992), Managing for Total Quality, Prentice Hall International, Englewood Cliffs, NJ.
3.	Grant.E.L., Stastical Quality Control, McGraw Hill
4.	Juran J.M, Gryna I.M., Quality Planning and Analysis, Tata McGraw Hill Publishing Company

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 712**
2. Course Title: **Optimization for Engineering Design**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **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: Define and use optimization terminology and concepts, and understand how to classify an optimization problem.

Course Outcome 2: Apply optimization methods to engineering problems, including developing a model, defining an optimization problem, applying optimization methods, exploring the solution, and interpreting results. Students will demonstrate the ability to choose and justify optimization techniques that are appropriate for solving realistic engineering problems.

Course Outcome 3: Understand and apply unconstrained optimization theory for continuous problems, including the necessary and sufficient optimality conditions and algorithms such as: steepest descent, Newton's method, conjugate gradient, and quasi-Newton methods.

Course Outcome 4: Be able to implement basic optimization algorithms in a computational setting and apply existing optimization software packages to solve engineering problems.

Course Outcome 5: Understand and apply gradient-free and discrete optimization algorithms such as: genetic algorithms

11. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Introduction** Introduction to design and specifically system design, Morphology of design with a flow chart, Market analysis, profit, time value of money, an example of discounted cash flow technique, Concept of workable design, practical example on workable system and optimal design.	
2.	**System Simulation** Classification, Successive substitution method – examples, Newton Raphson method - one unknown – examples, Newton Raphson method - multiple unknowns – examples, Gauss Seidel method – examples, Rudiments of finite difference method for partial differential equations, with an example.	
3.	**Regression and Curve Fitting** Need for regression in simulation and optimization, Concept of best fit and exact fit, Exact fit - Lagrange interpolation, Newton's divided difference – examples, Least square regression - theory, examples from linear regression with one and more unknowns – examples, Power law forms – examples, Gauss Newton method for non-linear least squares regression - examples.	
4.	**Optimization** Introduction, Formulation of optimization problems – examples, Calculus techniques – Lagrange multiplier method – proof, examples, Search methods – Concept of interval of uncertainty, reduction ratio, reduction ratios of simple search techniques like exhaustive search, dichotomous search, Fibonacci search and Golden section search – numerical examples, Method of steepest ascent/ steepest descent, conjugate gradient method – examples.	
5.	**New generation optimization techniques** Genetic algorithm and simulated annealing – examples, Introduction to Bayesian framework for optimization- examples.	
	Total	

12. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Essentials of Thermal System Design and Optimization, Prof. C. Balaji, Aue Books, New Delhi in India and CRC Press in the rest of the world.
2.	Design and optimization of thermal systems, Y.Jaluria, Mc Graw Hill, 1998.
3.	Elements of thermal fluid system design, L.C.Burmeister, Prentice Hall, 1998.
4.	Design of thermal systems, W.F.Stoecker, Mc Graw Hill, 1989.
5.	Introduction to optimum design, J.S.Arora, Mc Graw Hill, 1989.
6.	Optimization for engineering design - algorithms and examples, K.Deb, Prentice Hall, 1995

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 713**
2. Course Title: **TRIBOLOGY (Revised in 2019)**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

6. Credits**: 3** **7.** Semester**: VII** **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.

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:

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

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PME 711**
2. Course Title: **AUTOMATION AND CNC LAB (Revised in 2019)**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **3** **Mid** **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.

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. Lab Code: **PAE 712**
2. Course Title: **HYDAULIC & PNEUMATIC SYSTEM LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **3** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **PSM** **25**

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

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

10. List of Experiments:

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

1. To measure the surface Tension of a liquid.
3. Determination of coefficient of friction of flow in a pipe.
4. Determination of minor losses in flow through pipes.
5. To determine the coefficient of discharge of orifice plate meter.
6. Determination of force developed by impact jets on vanes.
7. Performance testing of Pelton Wheel
8. Performance testing of Francis Turbine.
9. Performance testing of Single stage / Multi stage Centrifugal Pump.
10. Performance testing of Reciprocating Pump.
11. Direct control of double acting cylinder
12. Memory circuit and speed control of a cylinder
13. Pressure dependent control of double acting cylinder
14. Implementation of logical OR function using pneumatic components.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 801**
2. Course Title: **AUTOMOTIVE ENGINE POLLUTION AND CONTROL**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

9. Pre-requisite**: I C Engine**

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	**TRODUCTION**: Pollutants-sources-formation-effects-transient operational effects on pollution.	08
2.	**SI ENGINE COMBUSTION AND POLLUTANT FORMATION**: Chemistry of SI engine Combustion, HC and CO formation in 4stroke and 2 stroke SI engines, NO formation in SI Engines, Effect of operating variables on emission formation.	08
3.	**CI ENGINE COMBUSTION AND EMISSIONS**: Basic of diesel combustion-Smoke emission in diesel engines- Particulate emission in diesel engines. Color and aldehyde emissions from diesel engines, Effect of operating variables on emission formation.	08
4.	**CONTROL TECHNIQUES FOR SI AND CI**: Design changes, optimization of operating factors, exhaust gas recirculation, fumigation, air injector PCV system-Exhaust treatment in SI engines-Thermal reactors-Catalytic converters, Catalysts, Use of unleaded petrol.	08

5.	**TEST PROCEDURE & INSTRUMENTATION FOR EMISSION MEASUREMENT AND EMISSION STANDARDS:** Test procedures-NDIR analyzer, Flame ionization detectors, Chemiluminescent analyzer, Gas chromatograph, Smoke meters, Emission standards.	**08**
	Total	**40**

11. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Mathur M. L., Internal Combustion Engines
2.	Ganesan. V., Internal Combustion Engines, Tata McGraw Hill Co.
3.	Heywood. J.B., Internal Combustion Engine Fundamentals, McGraw Hill Book Co.
4.	Taylor. C.F., Internal Combustion Engines, MIT Press.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 802**
2. Course Title: **POWER PLANT ENGINEERING (Revised in 2019)**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

4 **6.** Credits**:** **7.** Semester**: VIII** **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.

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 Problems) Introduction to NCER. Study of Indian Hydro Power Scenario	**08**
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.
4.	Power Plant Technology, El-Vakil, McGraw Hill.

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 821**
2. Course Title: **VEHICLE BODY ENGINEERING AND SAFETY**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage: **MSE** **25** **ESE** **50** **TSM** **25**

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

9. Pre-requisite: **Nil**

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	**MATERIALS** Structural materials: Aluminum alloy sheet, extrusion and casting, Austenitic and Ferritic stainless steels, alloysteels. Different types of composites, FRP & metal Matrix Composites. Structural timbers properties designing inGRP and high strength composites different manufacturing techniques of composites.Thermo plastics, ABS and styrenes. Load bearing plastics, semi rigid PUR foams and sandwich panelconstruction	08
2.	**ERGONOMICS ANDCONTROLS** Shaping and packaging: Product design and concepts, Aesthetics and industrial design, formal aesthetics andshape, computer aided drafting, surface development, interior ergonomics, ergonomics system design, dashboardinstruments, advances in electronic display, CV legal dimension. CV-cab ergonomics, mechanical packagelayout. Body Fitting and I Controls: Driver's seat, window winding mechanism, Door lock mechanism, otherinterior mechanisms, driver's visibility' and tests for, visibility, minimum space, requirements and methods orimproving space in cars, electric wiring and electronic control systems, advanced body electronics, networking orbody systems controls.	08

3.	**AERODYNAMICSAND FORCE ANALYSIS** Aerodynamics: Basics, aerofoils, aerodynamics drag lift, pitching, yawing and rolling moments, determination ofaerodynamic coefficients (wind tunnel testing), racing car aerodynamics, bluff body aerodynamics, local air flows. LoadDistribution: Types of load carrying structures -closed, integral, open, flat types. Calculation of loading cases-static,asymmetric, vertical loads. Load distribution, stress analysis of structure, body shell analysis.	**08**
4.	**STRUCTURAL DYNAMICS** Noise, Vibration, Harshness: Noise and vibration basics, body structural vibrations, chasis bearing vibration, designingagainst fatigue, rubber as an isolator. CV body mountings, automatic enclosures, sandwich panels, structure dynamicsapplied, surety under impact: Impact protection basics, design for crash worthiness, occupant and cargo restraints. Passiverestraint systems, slide impact analysis, bumper system, energy absorbant foams, laws of mechanisms applied 10 safety.Vehicle stability: Steering geometry vehicle and a curvilinear path, and lateral stability, effects of tyre factors, mass distribution and engine location on stability.	**08**
5.	**TYPES OFVEHICLES** Vans, trucks and buses: Types of mini coach with trailers, single and double deckers, design criteria basedon passenger capacity, goods to be transported and distance to be Covered, constructional details: weightsand dimensions, conventional and integral type.	**08**
	Total	**40**

11. Suggested Books:

No.	**Name of Authors /Books /Publisher**
1.	Body Engineering -Sydney F Page
2.	Vehicle body engineering -Giles J Pawlowski
3.	Automotive chassis -P.M. Heldt. chilton & Co
4.	Handbook on vehicle body design -SAE Publications.

GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 822**
2. Course Title: **AUTOMOTIVE AERODYNAMICS**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **TSM** **25**

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

9. Pre-requisite**: Nil**

10. Details of Course:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION** Scope - historical development trends - Fundamental of fluid mechanics - Flow phenomenon related to vehicles External & Internal flow problem - Resistance to vehicle motion -performance - Fuel consumption and performance - Potential of vehicle aerodynamics.	08
2.	**AERODYNAMICS OF VEHICLES-FUNDAMENTALS** Cars as a bluff body - Flow field around car - drag force - types of drag force - analysis of aerodynamic drag –drag coefficient of cars - strategies for aerodynamic development - low drag profiles.	08
3.	**SHAPE OPTIMIZATION OF CARS** Front end modification - front and rear wind shield angle - Boat tailing - Hatch back, fast back and square back, Dust flow patterns at the rear - Effects of gap configuration - effect of fasteners.	08
4.	**VEHICLE HANDLING** The origin of forces and moments on a vehicle - side wind problems - methods to calculate forces and moments -vehicle dynamics Under side winds - the effects and moments - Characteristics moments -Dirt accumulation on the vehicle - wind noise - drag reduction in commercial vehicles.	08

5.	**WIND TUNNELS FOR AUTOMOTIVE AERODYNAMIC** Introduction - Principle of wind tunnel technology - Limitation of simulation - Stress with scale models – full scale wind tunnels - measurement techniques - Equipment arid transducers - road testing methods – Numerical methods.	**08**
	Total	**40**

11. Suggested Books:

No.	**Name of Authors /Books /Publisher**
1.	Hucho. W.H., "Aerodynamic of Road vehicles ", Butterworths Co. Ltd., 1997.
2.	Pope. A., "Wind Tunnel Testing ", John Wiley & Sons, 2ndEdn, New York, 1974.
3.	Brawand et al., “Aerodynamics of heavy vehicles, Trucks Buses and trains-Vol-41”, Springer.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TAE 823**
2. Course Title: **AUTOMOTIVE ELECTRICAL AND AUTOTRONICS**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **1.5** **Mid** **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. Details of Course:

Unit No.	Contents	Contact Hours
1.	**Automotive Battery: Construction and Service.** Battery operation (Battery operation, chemicals in battery, battery construction, connecting cells, battery ratings, battery efficiency, variations in terminal voltage). Battery maintenance and service. Battery testing (open-circuit voltage test, hydrometer test, variations in specific gravity, battery load test). Battery charging. **New developments in electrical storage.** Lead-acid battery developments, maintenance-free batteries, alkaline batteries, the ZEBRA battery, ultracapacitors, fuel cells, fuel cell developments, sodium sulphur battery, the Swing battery. New developments in batteries (Bosch silver battery).	**08**
2.	**Starting System.** Need for starting system, basic motor principles, types of electrical circuits in starter motors (series, parallel and compound), starting-motor construction and operation, starting motor drive, inertia drive (standard Bendix drive and Folo through drive), overrunning clutch, permanent-magnet starting motors. Starting system testing (current-draw test and no-load test). **New developments in starting systems.** Belt-driven starter-generator. **Charging System.** Purpose of charging system, direct current (DC) generator (introduction only), alternator operation, alternator principles, alternator regulator, alternator terminals, alternator cooling, instrument-panel charge indicators, charging-system testing. **New developments in charging systems.** Water-cooled alternators	**08**

3.	**Ignition Systems.** Ignition fundamentals (functional requirements, types of ignition system (battery and electronic), components of battery ignition system, ignition timing, advancing the spark, centrifugal advance, vacuum advance), ignition coil cores, electronic ignition (introduction, transistorized ignition system, Hall effect pulse generator, inductive pulse generator, other pulse generators, capacitor discharge ignition), programmed ignition (sensors and input information, ignition control unit), distributorless ignition, direct ignition, spark plugs, ignition switch. **Electronic fuel control.** Fuel injection, diesel fuel injection, Bosch diesel systems (Third generation common rail with piezoelectric inline injectors).	**08**
4.	**Lights, Safety and Signalling, and Driver Information and Control Devices.** Automotive lighting (automotive lights, light bulbs, headlamps, headlamp switch, automatic headlamp controls, turn-signal lights, fibre-optic lighting, computer-controlled lighting, distributed lighting system, headlamp aiming), HID and LED lighting (high-intensity gas discharge lamps, ultraviolet headlights, LED lighting). Safety and signalling (horn and horn relay, vehicle security systems, seat belts, air bags, air-bag replacement, windshield wipers and washers), driver information and controls (instrument panel, head-up display, speedometer and odometer, multiplexing and other electrical and electronic devices (tachometer, fuel gauge, coolant temperature gauge, mirrors, sunvisor, sunroof).	**08**
5.	**Electronic principles.** Electronic components and circuits (integrated circuits, amplifiers, bridge circuits, Schmitt trigger, timers, filters, Darlington pair, stepper motor driver, digital to analogue conversion, analogue to digital conversion), digital electronics (introduction to digital circuits, logic gates, combinational logic, sequential logic, timers and counters, memory circuits, clock or astable circuits), microprocessor systems (introduction, central processing unit (CPU), memory, a typical microprocessor, microcontrollers), sensors (thermistors, inductive sensors, Hall effect, strain gauges, variable capacitance, variable resistance, accelerometer, linear variable differential transformer (LVDT), hot wire air flow sensor, light sensors, rain sensor, dynamic vehicle position sensors), actuators (introduction, solenoid actuators, motorized actuators, stepper motors, synchronous motors, thermal actuators). **Tools and test equipment.** Basic equipment, multimeters, specialist equipment, dedicated equipment.	**09**
	Total	**41**

11. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Tom Denton, “Automobile Electrical and Electronic Systems”, Third Edition, Elsevier.

2.	William H. Crouse and Donald L Anglin, "Automotive Mechanics", Tenth Edition, 2015, McGraw Hill Education.
3.	S. K. Gupta, "A Textbook of Automobile Engineering", S. Chand.
4.	Jacob Millman and Arvin Grabel, "Microelectronics", Second Edition, 2001, TMH.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PAE 811**
2. Course Title: **AUTOMOTIVE ENGINE AND CHASSIS COMPONENTS LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **3** **Mid** **End** **3**
5. Relative Weightage**: MSE** **25** **ESE** **50** **PSM** **25**

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

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

10. List of Experiments:

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

1. Study of frames used for HMV, LMV and Two wheelers.
2. Study and demonstration dismantling and assembling of engine.
3. Study and demonstration of fuel supply system.
4. Study and demonstration of steering system.
5. Study and demonstration of Suspension system.
6. Study and demonstration of braking system.
7. Study and demonstration of brake adjustment and bleeding.
8. Study and demonstration of Ignition system.
9. Study and demonstration of cooling system.
10. Study and demonstration of lightning system.
11. Study and demonstration of universal joint, propeller shaft, differential,
12. Study of driver seat.
13. Study and demonstration dismantling and assembling of wheels and tyres.
14. Study and demonstration dismantling and assembling of simple 2 S engine carburetor.