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COURSE COMPONENTS OF ACADEMIC PROGRAMME

UNDERGRADUATE PROGRAMME

B.Tech Mechanical Engineering with specialization in

Robotics and Automation

Batch 2017-21

Minimum Duration: 8 Semesters (4 years)

Maximum Duration: 12 Semesters (6 years)

Total number of credits: 212 credits

Course Components			Credits
1. Compulsory courses			
i.	Foundation course (FC)		59
ii.	Core course (CC)		108
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)

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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.	TME302	Material Science andMetallurgy	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	ManufacturingProcesses I	3	1	0	4	25	25	50	100
	Labs									
6.	PME311	Computer Aided Machine Drawing	0	0	6	4	25	25	50	100
7.	PME312	Metallography &Material Testing Laboratory	0	0	3	1	25	25	50	100
8.	PME313	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:PracticalsMT:MidtermExaminations

Att.:Attendance Asmt.:TeachersAssessmentas Assignments,Seminar,

LR:LabRecord ESE:EndSemesterExamination

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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

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LR:LabRecord ESE:EndSemesterExamination

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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.	TRA504	Robotics	3	0	0	3	25	25	50	100
5.	TRA505	Electrical and Electronics Measuring Instruments	3	0	0	3	25	25	50	100
	Labs									
6.	PME511	HMT Lab	0	0	3	1	25	25	50	100
7.	PME512	DOM Lab	0	0	3	1	25	25	50	100
8.	PRA513	Electrical Measurement 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	25	225	225	650	1100

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SEMESTER-VI

S NO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt./ LR/ Att	ESE	Total
	Theory									
1.	TME601	Refrigeration and AirConditioning	3	1	0	4	25	25	50	100
2.	TME602	Design of Machine Elements -II	3	1	0	4	25	25	50	100
3.	TRA603	Automatic Control	3	0	0	3	25	25	50	100
4.	TRA604	Microprocessor and its applications	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.	PME 612	Design Lab	0	0	3	1	25	25	50	100
8.	PRA613	Microprocessor and its applications 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

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SEMESTER-VII

S NO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt. / LR/Att	ESE	Total
	Theory									
1.	TME701	Mechanical Vibrations	3	0	0	3	25	25	50	100
2.	TME702	CAD/CAM	3	1	0	4	25	25	50	100
3.	TRA 703	Mechatronics	3	0	0	3	25	25	50	100
4.	TRA704	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.	PRA712	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
TRA711	Modeling and Simulation
TRA712	Sensors applications in manufacturing
TAE 713	Tribology

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SEMESTER-VIII

SNO	SUB CODE	SUBJECT	L	T	P	TC	MT	Asmt. / LR/Att	ESE	Total
	Theory									
1.	TRA801	CNC and Programming	3	0	0	3	25	25	50	100
2.	TME802	Power plant Engineering	3	1	0	4	25	25	50	100
3.		ElectiveIII	3	0	0	3	25	25	50	100
4.	UCE801	Disaster Management	3	0	0	3	25	25	50	100
	Labs									
5.	PRA811	Product design And development 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
TME811	Computer Integrated Manufacturing
TME812	Non-Conventional Energy Resources
TME813	Agile Manufacturing

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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.): **Mid** 1.5 **End** 3

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

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

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

10. Course Outcome:

Course Outcome 1: Understand the 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.	Structure of crystalline solids: Miller indices, space lattice & concept of unit cell(cubic, HCP structure) including bravais lattices, stacking in cubic & HCP. Calculation of radius, coordination no. & A.P.F. for different cubic structures. Calculations on density. Crystal Imperfections – point, line & surface defects. Diffusion & fick's law of diffusion.	**08**
2.	Elastic deformation & plastic deformation (Slip & twinning). Interpretation of tensile stress-strain curve & mechanical properties, true stress & strain. Fracture & its types, stages in cup & cone fracture. Fatigue:Crack initiation & propagation, fatigue test & S-N curve. Factors affecting	**08**

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	fatigue life & protection methods. Creep: Creep test & creep curve. Creep mechanism & creep resistant materials.	
3.	Phase Diagrams: Basic terms, Gibb's phase rule, types of solid solution & rules for governing it. Unary(Fe) phase diagram, binary phase diagram(with partial & complete solid – liquid solubility, Ag – Pt system), lever rule & its application. Iron – carbon equilibrium diagram (Phases, invariant reactions, critical temperatures, microstructures of slowly cooled alloys), TTT diagram, CCT diagram.	**09**
4.	Methods for manufacturing the steel: Heat treatment & its importance. Annealing & its types, normalizing, hardening, tempering (martempering & austempering). Jomint end – quench test. Surface hardening like case hardening, carburizing, Cyaniding, Nitriding, Induction hardening. Corrosion & methods employed to prevent corrosion.	**07**
5.	Engineering Materials: properties, composition & applications of low, medium & high carbon steels. Steel designation(AISI & SAE).Types, applications and mechanical behavior of ceramics , polymers Introduction to Nano materials, Properties and behavior of nano materials.	**08**
	Total	**40**

12. Suggested Books:

No.	Name of Authors /Books /Publisher
1.	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

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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.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **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

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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**

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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

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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.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **Nil**

10. Course Outcome:

Course Outcome 1: Understand the basic terminology, definitions and fundamental concepts of thermodynamics

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'	08

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	experiment, First law analysis for closed system (non flow processes), Internal energy and enthalpy. Limitations of first law of thermodynamics, PMM-I.	
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. **Availability 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, 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.	**08**
	Total	**40**

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12.Suggested Books:

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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.

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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.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **Nil**

10. Course Outcome:

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

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

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

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

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

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

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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.

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2.	Manufacturing Engineering and Technology by SeropeKalpakjian and Stevan
3.	Manufacturing Science,hyAmitabha Ghosh & A.K. Malik - East -Westpress 2001
4.	Principles of Industrial metal working process - G.W. Rowe, CBSpub. 2002

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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.): **Mid** 3 **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. Orthographic views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.	08

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2.	**Thread forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. **steners**: 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

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2.	'Machine Drawing' , N. Siddeshwar, P. Kanniah, V.V.S. Sastri,published by Tata Mc GrawHill,2006
3.	'A Text Book of Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007
4.	'Machine Drawing with Auto CAD'. Goutam Pohit & Goutham Ghosh, IST Indian print Pearson Education, 2005
5.	'Auto CAD 2006, for engineers and designers'. Sham Tickoo. Dream tech

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PME 312**
2. Course Title: **METALLOGRAPHY AND MATERIAL TESTING LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 1 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **Material Science, Mechanics of Material**

10. Course Outcome:

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

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

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

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

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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.

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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.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 1 **7.** Semester: **III** **8.** Subject Area: **CC**
9. Pre-requisite: **Manufacturing Processes**

10. Course Outcome:

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

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

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

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

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.

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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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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.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: IV** **8.** Subject Area**: CC**
9. Pre-requisite**:** **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). Stirling cycle, Lenoir cycle, Atkinson cycle and Ericsson cycle - (description on P-v and T-s diagrams only).	08

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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.	**SYCHROMETRICS: -** 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.

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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.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: IV** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Nil**

10. Course Outcome:

Course Outcome 1: 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	08

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	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.	
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**

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12.Suggested Books:

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1.	Human Factor Engineering: Sanders & McCormick McGraw Hill Publications.
2.	echanical estimating & Costing - T R banga, S C Sharma, Khanna Publishing house
3.	Work Study and Ergonomics - S Dalela and Sourabh, - Chand Publishers, 3rd edition.
4.	Motion and Time study - Ralph M Barnes; John Wiley, 8th Edition, 1985

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

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

10. Course Outcome:

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

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

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

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

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

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

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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.	**rret and capstan (Lathe), shaping, planning machines and Drilling machines**: Classification, constructional features of turret and capstan lathe, tool layout, shaping m/c, planning m/c, driving mechanisms of lathe, shaping and planning machines, operations on lathe, shaping machine and planning machine. Drilling machines: Classification, constructional features, drilling & related operations, types of drill & drill bit nomenclature, drill materials,	08
3.	**Milling machines**: Classification, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concepts, indexing**,** **inding machines**: Types of abrasives, bonding process, classification, constructional features (Cylindrical and surface grinding), and selection of grinding wheel. Lapping and Honing machines: Principles of operation, construction, applications.	08
4.	**lding operations:** survey of welding processes, position of welding, joint types, **Gas welding:** process and equipment details, **Gas cutting**, process and equipment details, flame types, **Arc welding:** process and equipment details, power sources, electrode details. **TIG & MIG** processes and their parameters. **Resistance welding**: types and details, atomic hydrogen, submerged arc, electroslag, friction welding, soldering and brazing, Thermodynamics and metallurgical aspects in welding ,shrinkages, distortions, residual stresses generation in HAZ and remedies, defects in welding and remedies.	08
5.	**nconventional Manufacturing process:** Introduction, HERF, process parameters – Abrasive jet machining, water jet machining, ultrasonic machining, chemical machining, electro chemical machining, electric discharge machining, electron beam machining, plasma arc machining.	08
	Total	**40**

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12.Suggested Books:

S. 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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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.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: IV** **8.** Subject Area**: CC**
9. Pre-requisite**:** **Nil**

10. Course Outcome:

Course Outcome 1: 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.

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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

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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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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.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **IV** **8.** Subject Area: **CC**
9. Pre-requisite: **Nil**

10. Course Outcome:

Course Outcome 1: 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.

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11.Details of Course:

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

12.Suggested Books:

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

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

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

10. Course Outcome:

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

Course Outcome 2: To understand and apply various surface finishing techniques.

For external surface: Surface Grinding Machine

For internal surface : Tapping &Drilling Machine

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

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

11. List of Experiments:

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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.

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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.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 1 **7.** Semester: **IV** **8.** Subject Area: **CC**
9. Pre-requisite: **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.

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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.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PME 413**
2. Course Title: **MEASUREMENTS AND METROLOGY LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 1 **7.** Semester: **IV** **8.** Subject Area: **CC**
9. Pre-requisite: **Basics of Measurements and Metrology**

10. Course Outcome:

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

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

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

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

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11.List of Experiments:

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

1. Study and measurement by Vernier Calliper

2. Study and measurement by micrometer

3. Calibration of micrometer using slip gauges set

4. Study and angle measurement by sine bar

5. Study and angle measurement by bevel protractor

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

7. Determination of strain using strain gauge transducer

8. To study the performance characteristics of a load cell

9. To study the performance characteristics of a thermocouple

10. Study of linear variable differential transformer (LVDT)

11. Measurement of cutting tool force using Lathe tool dynamometer

12. Measurement of cutting tool force using Drill tool dynamometer

13. Study of various types of gauges

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

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OFDEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TME 501** (Revised in 2019)
2. CourseTitle: **HEAT AND MASS TRANSFER**
3. ContactHours: **L:3** **T: 1** **P: 0**
4. ExaminationDuration(Hrs.): **Mid** 1.5 **End** 3
5. RelativeWeightage**: 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 insulationand basics of transient conduction.

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

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

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

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

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

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11.Details ofCourse:

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**

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

12.SuggestedBooks:

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

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 502**
2. Course Title: **DESIGN OF MACHINE ELEMENTS-I**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.** Semester**: V** **8.** Subject Area**: CC**
9. Pre-requisite**:** **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	09

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	Concentration.	
3.	**Design for Fatigue Strength**: Introduction- S-N Diagram, Low Cycle Fatigue, High Cycle Fatigue, Endurance Limit, Endurance Limit. Modifying Factors: Size effect, Surface effect, Stress Concentration effects. Fluctuating Stresses, Goodman and Soderberg relationship; Stresses due to Combined Loading, Cumulative Fatigue Damage.	**09**
4.	**Design of Shafts and Keys**: Torsion of Shafts, Design for strength and Rigidity with Steady loading, ASME & BIS codes for Power Transmission shafting, Shafts under Fluctuating loads and Combined loads. Keys: Types of keys, Design of Keys	**09**
5.	**Design of Riveted, Welded, and threaded Joints :** Types, design of riveted joints. Boiler shell riveting, eccentric loading, Strength of Butt, parallel, transverse welds, eccentrically loaded welded joint subjected to torsion & Bending moment, Design of threaded fasteners, thread forms and threaded fastener types and materials, bolt tightening and initial tension, static and group of bolts.	**10**
	Total	**45**

12.Suggested Books:

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

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 503**
2. Course Title: **DYNAMICS OF MACHINES**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **V** **8.** Subject Area: **CC**
9. Pre-requisite: **Kinematics of Machines**

10. Course Outcomes:

Course Outcome 1: Understand static Force equilibrium conditions in mechanisms.

Course Outcome 2: Analyse concept of Dynamic Forces and understand its application in Flywheels.

Course Outcome 3: Characterize application of friction in bearings, clutches and Belt Drives.

Course Outcome 4: Analyse balancing of rotating and reciprocating masses.

Course Outcome 5: Understand and analyse the concept and characteristics of governors

Course Outcome 6: Understand and apply the concept of gyroscopic effect in ships, aeroplane and road vehicles

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

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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.	**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.	**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 OFDEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TRA504**

2. CourseTitle: **ROBOTICS**

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

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

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

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

9.Pre-requisite**:** **Mathematics and Physics**

10. Course Outcome:

Course Outcome 1: Understand different aspects in the field of robotics and its interdisciplinary approach.

Course Outcome 2: Develop the direct and inverse kinematic models of different robotic configurations.

Course Outcome 3: Analyze differential motion and singularities in robotic manipulators.

Course Outcome 4: Develop dynamic model of robotic manipulators.

Course Outcome 5: Develop trajectory planning and control schemes for robotic manipulators.

11.Details ofCourse:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION:** Definition, classification of robots, historical evolution, characteristics of robots, industrial robot anatomy, manipulators, actuators, sensors, end-effectors, robot configurations.	06

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2.	**MANIPULATOR KINEMATICS:** Coordinate frames, mapping and transformation, Denavit—Hartenberg notation, direct kinematic modeling, inverse kinematics.	**08**
3.	**MANIPULATORDIFFERENTIAL MOTION:** Differential translation and rotation, Derivatives of homogeneous transformations, manipulator Jacobian, inverse Jacobian, singularities, static force and moment analysis.	**08**
4.	**MANIPULATOR DYNAMICS:** Acceleration of a rigid body, mass distribution, Newton's and Euler's equations, iterative Newton-Euler formulation, Lagrange-Euler formulation of manipulator dynamics.	**07**
5.	**TRAJECTORY PLANNING AND CONTROL OF MANIPULATORS:** Introduction to trajectory planning techniques, joint-space scheme, introduction to control schemes, control law partitioning, force and torque control.	**07**
	Total	**36**

12.SuggestedBooks:

S. No.	Name of Authors /Books /Publisher
1.	Craig, J. J. (2005). *Introduction to robotics: mechanics and control*. Pearson Prentice Hall
2.	Niku, S. B. (2001). *Introduction to robotics: analysis, systems, applications*. Prentice Hall.
3.	Mittal, R. K., & Nagrath, I. J. (2003). *Robotics and control*. New Delhi: Tata McGraw-Hill.

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NAME OFDEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TRA505**

2. CourseTitle: **Electrical and Electronics Measuring Instruments**

3. ContactHours: **L:3** **T: 1** **P: 0**

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

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

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

9.Pre-requisite**:** **Mathematics and Physics**

10. Course Outcome:

1. Understand the concept of measurement and different measuring instruments.
2. Understand instrument transformer and its application.
3. Estimate electrical quantities through measuring instruments.
4. Utilize AC potentiometer, galvanometer and flux meter in the measurement of electrical and magnetic characteristics
5. Develop the concept of digital measurement of electrical quantities.
6. Analyze various electrical signals through cathode ray oscilloscope and power analyzer.

11.Details ofCourse:

Unit No.	Contents	Contact Hours
1.	**Unit1:** **Introduction to Measurement:**Methods of Measurement, Classification of instrument system, Characteristic of instrument & measurement system, Errors in Measurement & its Analysis.	06
2.	**Unit 2:** **Analog Measurement of Electrical Quantities:** Principle of operations	08

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	and torque equations for different types of instruments, PMMC, Moving Iron (attraction and repulsion type), Electrodynamometer, Thermocouple, Electrostatic & rectifier type Ammeters & Voltmeters, True RMS reading voltmeters, Electrodynamometer type Wattmeter, Three Phase Wattmeter, Power in three Phase System.	
3.	**Unit 3:** **Measurement of Electrical Quantities:** Measurement of Frequency and Power factor, Different methods of measuring low, medium and high resistances, Measurement of Inductance & Capacitance with the help of AC Bridge, Q Meter.	**07**
4.	**Unit 4:** **Instrument Transformer:** Instrument Transformer and their application in the extension of instrument range. Difference between CT and PT, transformation ratio and phase angle error for CT and PT, causes of errors, reduction of errors, effect of secondary open circuit for CT.	**07**
5.	**Unit 5:** **Digital Measurement of Electrical Quantities:** Concept of digital Measurement, digital voltmeter and its types. **Cathode Ray Oscilloscope:** Introduction, cathode ray tube, electron gun, electrostatic focusing, electrostatic deflection plates, time base generator, Attenuator, synchronization, storage oscilloscope, observations of waveform on CRO, , measurements using CRO – Voltage, Frequency, Period, Phase.	**08**
	Total	**36**

12.SuggestedBooks:

S. No.	Name of Authors /Books /Publisher
1.	A.K. Sawhney: "Electrical & Electronic Measurement & Instrument", DhanpatRai& Sons, India.
2.	E.W. Golding & F.C. Widdis, "Electrical Measurement &Measuring Instrument", A.W. Wheeler & Co. Pvt. Ltd. India.
3.	**Reference Book:1.** Forest K. Harries, "Electrical Measurement", Willey Eastern Pvt. Ltd. India. **2**.M.B. Stout, "Basic Electrical Measurement", prentice hall of India, India. **3.**W.D. Cooper," Electronic Instrument & Measurement Technique "Prentice hall International

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OFDEPARTMENT: **Department of Mechanical Engineering**

1. LabCode: **PME 511 (Revised in 2019)**
2. CourseTitle: **HEAT & MASS TRANSFER LAB**
3. ContactHours: **L:0** **T: 0** **P: 3**
4. ExaminationDuration(Hrs.): **Mid** 3 **End** 3
5. RelativeWeightage: **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.

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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.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PME 512**
2. Course Title: **DYNAMICS OF MACHINES LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 1 **7.** Semester: **V** **8.** Subject Area: **CC**
9. Pre-requisite: **Dynamics of Machine**

10. Course Outcome:

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

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

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

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

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 of various links with the help of Models.

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

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

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5. Determination of coefficient of friction for various surfaces.

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

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

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

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

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

11. Experiment on Static balancing machine for static balancing.

12. Experiment on dynamic balancing machine for dynamic balancing.

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

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

Innovative Experiments

15. To study the motion of the follower for different profiles of cams and find the displacement, velocity and acceleration.

16. To determine the Moment of Inertia of a Flywheel about its own axis of rotation.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Lab Code: **PRA 513**
2. Course Title: **ELECTRICAL MEASUREMENT LAB**
3. Contact Hours: **L: 0** **T: 0** **P: 3**
4. Examination Duration (Hrs.): **Mid** 3 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **PSM** 25
6. Credits: 1 **7.** Semester: **V** **8.** Subject Area: **CC**
9. Pre-requisite:

10. Course Outcome

11. List of Experiments:

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

1. To calibrate AC voltmeter and AC ammeter using standard AC voltmeter and standard AC ammeter.
2. To measure the Quality factor and inductance of the coil using Maxwell's bridge.
3. To measure the Quality factor and inductance of the coil using Hay's bridge.
4. To measure high value of AC current by a low range AC ammeter and Current Transformer (CT).
5. To measure high value of AC voltage by a low range AC voltmeter and Potential Transformer (PT).
6. To measure power using Current Transformer (CT) and Potential Transformer (PT).
7. Calibration of digital energy meter using wattmeter method.

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8. Calibration of digital Energy meter using Voltmeter/Ammeter method
9. To determine the unknown capacitance and dissipation factor of the unknown capacitor using Schering Bridge
10. To determine the unknown capacitance and dissipation factor of the unknown capacitor using De'sauty Bridge
11. To measure the power factor in a single phase AC circuit with the resistive and inductive (RL) load.
12. To analyze the improvement of power factor of RL network through capacitor.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OFDEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TME 601(Revised 2019)**
2. CourseTitle: **REFRIGERATION AND AIR CONDITIONING**
3. ContactHours: **L:3** **T: 1** **P: 0**
4. ExaminationDuration(Hrs.): **Mid** 1.5 **End** 3
5. RelativeWeightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 4 **7.**Semester**: VI** **8.** Subject Area**:CC**
9. Pre-requisite**:** **Basic Thermodynamics, Applied Thermodynamics**

10. Course Outcomes:

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

Course Outcome 2: Understand gas refrigeration system and its performance

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

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

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

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

11.Details ofCourse:

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	10

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	performance of VCRC, Actual VCRS & Variable refrigerant flow (*VRF*), Numerical problems. MULTI PRESSURE VAPOUR COMPRESSION SYSTEMS: Multi stage compression, Multievaporator systems, Cascade systems, calculation, production of solid carbon dioxide, Systempractices for multistage system.	
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 onenthalpy. 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: Types- Automatic expansion valve, Thermostatic expansion valves, capillary tube. Sizing Evaporator: Types & construction. LOAD CALCULATIONS AND APPLIED PSYCHOMETRICS: Internal heat gains, system heatgains, break up of ventilation load and effective sensible heat factor, Bypass factor, cooling loadestimate. Psychometric calculations for cooling. Selection of Air conditioning apparatus for coolingand dehumidification, evaporative cooling. Introduction to under floor air distribution(UFAD)	**10**
	Total	**45**

12. SuggestedBooks:

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, DhanpatRaiPublication
4.	'Principles of Refrigeration' Dossat, Pearson.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 602**
2. Course Title: **DESIGN OF MACHINE ELEMENTS II**
3. Contact Hours: **L: 3** **T: 1** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 4 **7.** Semester: **VI** **8.** Subject Area: **CC**
9. Pre-requisite: **Mechanics of Materials, Design of Machine Element I**

10. Course Outcomes:

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

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

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

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

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

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

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**SPRINGS** Introduction, Types of springs, material of spring	08

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	Helical coil springs: Stresses in Helical coil springs of circular and non- circular cross sections.Tension and compression springs, springs under fluctuating loads. **Leaf Springs:** Stresses in leaf springs. Equalized stresses, Energy stored in springs. roduction to Torsion, Belleville and Rubber springs	
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.	**SPUR AND HELICAL GEARS** Definitions, Terminology, Tooth profiles, Involute full depth & stub system, Force analysis, Stresses in gear tooth, Lewis equation and form factor, Design for strength, dynamic load and wear load, Formative/virtual number of teeth, Beam strength of helical gear tooth.	**09**
4.	**BEVEL AND WORM GEARS** Definitions, Terminology, Force analysis, Formative number of teeth, Design based on strength, dynamic and wear loads	**08**
5.	**SLIDING AND ROLLING CONTACT BEARINGS** pes and classification, terminologies, Mechanisms of Lubrication, bearing modulus, Coefficient of friction, Minimum oil film thickness, Heat Generated, Heat dissipated, Bearing Materials, Design of journal bearing, Life, Static & dynamic load capacity, equivalent load, Load-life relationship, Design - finding Life, selection from manufacture's catalogue.	**09**
	Total	**42**

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12.Suggested Books:

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

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NAME OFDEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TRA603**

2. CourseTitle: **AUTOMATIC CONTROL**

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

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

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

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

9.Pre-requisite**:** **Mathematics**

10. Course Outcome:

Course Outcome 1: Understand different types of control strategies used in dynamical systems.

Course Outcome 2: Modeling of several types of dynamical systems using transfer function and state-space approaches.

Course Outcome 3: Understand dynamic behavior of various physical systems such as mechanical, electrical, fluid, etc., using their mathematical model.

Course Outcome 4: Predict about stability of various dynamical systems.

Course Outcome 5: Understand different types of control strategies used in dynamical systems.

11.Details ofCourse:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION:** Control Systems, Open-loop and Closed-loop control, Laplace transform, Inverse Laplace transform, Solving linear time-invariant differential equations, Transfer function, Block diagrams.	06

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2.	**TRANSIENT & STEADY-STATE ANALYSIS:** Poles and zeroes, First order systems, Second order systems, Stability, Routh's stability criterion, Steady-state errors.	**07**
3.	**MODELING OF DYNAMIC SYSTEMS:** State-space representation, Modeling in transfer function and state-space of dynamic systems. Translational and rotational mechanical systems, Electrical systems, Electromechanical systems, Fluid systems, Thermal systems, Linearization of nonlinear systems, MATLAB programs.	**08**
4.	**ROOT LOCUS AND FREQUENCY RESPONSE ANALYSIS:** Root locus plots, Introduction to frequency response analysis, Bode diagrams, Polar plots, Nyquist plots, Nyquist stability criterion.	**07**
5.	**CONTROLLER DESIGN:** Basics of Proportional (P), Integral (I), and Derivative (D) actions. PI, PD, and PID controller design, Tuning rules for PID controllers. Speed control of a DC motor and MATLAB program.	**07**
	Total	**35**

12.SuggestedBooks:

S. No.	Name of Authors /Books /Publisher
1.	Ogata, K., *Modern Control Engineering*, Pearson Education Asia.
2.	Nagrath, I. J. and Gopal, M., *Control Systems Engineering*, New age international publishers.
3.	Kuo, B.C., *Automatic Control System*, 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: **TRA 604**
2. Course Title: **Microcontroller and Embedded System**
3. Contact Hours: **L: 3** **T:** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: VI** **8.** Subject Area**: CC**
9. Pre-requisite**: Microprocessor.**

10. Course Outcomes:

1. Understanding the concept of embedded system.
2. Programming of 8085 and 8086 with looping and time delay.
3. Assembly language programming of 8051.
4. Study of Ardunio IDE
5. Interfacing of different IC with 8051.
6. Design and develop systems based on 8051 micro-controllers and its interfaces.
7. Successful completion of this course will act as foundation for embedded system courses.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	MICROCONTROLLER*:* Difference between Microprocessors and Micro-controllers, Types of Micro-controllers, ARM Processor, Memory structure of 8051, Processor Architecture – Harvard v/s Von Neumann, CISC v/s RISC, 8051 Architecture , control storage, variable area, stack, hardware register space, SFR,8051 pin diagram..	07
2.	**8051 Instruction Set:** dressing modes, external addressing, Instruction execution, Instruction set – data movement, arithmetic, bit operators, branch, Software development tools like assemblers, simulators, O/P file formats. Assembling and running an 8051 program, 8051 data types, 8051 flag bits and the PSW register, 8051 register banks and stack	07
3.	**PROGRAMMING OF 8051 and INTERRUPTS:** Programming of 8051, I/O bit manipulation. Timer, counter, programming of timer, 8051 interrupts, Interrupts priority in the 8051, and interrupts programming.	07
4.	**INTRODUCTION TO ARDUINO IDE PLATFORM** Introduction to ATMEGA328 microcontroller and to Arduino IDE, Instruction Set, Hardware, Characteristics, Interfacing with different peripheral devices, Debugging hardware errors, Using PWM I/O pins, Interfacing Arduino hardware with Internet of Things	07
5.	**INTERFACING:** erfacing with 8051: LCD, Keyboard, ADC, DAC interfacing, Sensor interfacing and Signal Conditioning, Stepper motor and DC motor, Basics of serial communications, 8051 connection to RS-232, 8051 serial port programming assembly.	08
	Total	36

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12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Mazidi, The 8051 Microcontrollers & Embedded Systems, Pearson Education.
2.	Programming and Customizing the 8051 Micro-controller, Myke Predko, Tata McGraw-Hill edition.
3.	Brad Kendall, Arduino Make use of A complete beginner guide,
4.	**Reference Books** 1. Kenneth Ayala, The 8051 Microcontroller, West Publishing Company. 2. Julien Bayle, C-Programming for Arduino

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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.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 3 **7.** Semester: **VI** **8.** Subject Area: **DE**
9. Pre-requisite: **Mechanics of Material**

10. Course Outcomes:

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

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

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

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

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

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

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**Introduction to Finite element method:** History, basic ideas in a finite element solution, General finite element solution procedure, Discretization, FEM versus other numerical method techniques, Applications and advantages of FEM.	04
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	07

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

12.Suggested Books:

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

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

1. Subject Code: **TME 612**
2. Course Title: **QUALITY CONTROL**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: 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 - Employee involvement and empowerment-Suggestion system - Quality circle -Continuous process improvement - Juran's trilogy - PDSA cycle - Kaizen - Six-sigma -Crosby's quality treatment	08

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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).	**07**
	Total	**35**

12.Suggested Books:

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

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 613**
2. Course Title: **TOTAL QUALITY MANAGEMENT**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: 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.

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11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION:** finition of Quality, Dimensions of Quality, Quality costs - , Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Wheels of TQM, Benefits of TQM, Scope of TQM, Types of customers, Barriers to TQM Implementation. One relevant case study.	07
2.	**TQM PHILOSOPHIES and PRINCIPLES:** ality Management Philosophies: Deming Philosophy, Juran Philosophy, Juran trilogy, Taguchi and his quality loss function,Crosby and quality is free , PDCA and PDSA Cycle, 5S, Kaizen, Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment and performance appraisal One relevant case study.	07
3.	**STATISTICAL PROCESS CONTROL (SPC) and RELIABILITY:** 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 maintenanceTotal Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA. One relevant case study using free software for QFD an FMEA.	07
5.	**QUALITY SYSTEMS:** Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System - Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 - Concept, Requirements and Benefits. BIS Introduction and types of standards, TPS, DIN and other Quality standards One relevant case study.	07
	Total	35

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12.Suggested Books:

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

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

7. Lab Code: **PME 611**
8. Course Title: **REFRIGERATION & AIR-CONDITIONING LAB**

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

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

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

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

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

10. Course Outcome:

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

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

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

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

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11. List of Experiments:

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

1. Study and performance of domestic refrigerator.
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. Performance study of refrigeration system & determination of COP.
7. Study and performance of window type air conditioning system.
8. Study of all weather year - round air conditioning system.
9. Study of defrosting in refrigeration.
10. Study of evaporator and condenser.
11. To study the cut sectional model of reciprocating, rotary and centrifugal compressor.
12. To study the various controls used in Refrigeration and Air conditioning system.
13. To study different psychometric process & chart.
14. To Study working principle of steam jet refrigeration system.

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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

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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**

7. Lab Code: **PRA613**
8. Course Title: **Microcontroller and Embedded system Lab.**

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

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

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

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

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

10. Course Outcome:

1. Understanding of 8051 microcontroller Kit & its associated peripherals.
2. Implementation of different assembly language programs on microprocessor based microcomputer kit.
3. Ability to test and debug assembly language program in the laboratory.
4. Understand real mode Memory addressing and ability to interface various devices to the microprocessor.

11. List of Experiments:

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

Sl. No.	Contents
1.	a) Write a program in 8051 to add two 8 bit numbers. b) Write a program in 8051 to subtract two 8 bit numbers.
2.	a) Write a program in 8051 to add two 16 bit numbers. b) Write a program in 8051 to subtract two 16 bit numbers.
3.	a) Write a program in 8051 to find the largest no. from an array of n numbers stored in an array.

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	b) Write a program in 8051 to perform smallest no. from an array of n numbers stored
4.	Write a program in 8051 to add two 8 bit BCD numbers.
5.	a) Write a program in 8051 to multiply two 8 bit data. b) Write a program in 8051 to divide two 8 bit data.
6.	Write a program in 8051 to convert a BCD number to its ASCII code equivalent.
7.	Write a program in 8051 which move a block of data.
8.	Write a program in 8051 which sort a block of data.
9.	Write a program in 8051 which convert a binary number to its grey code equivalent
10.	Write a program in 8051 which determines average of n numbers.
11.	Write a program in 8051 to convert a BCD number to its binary code equivalent
12.	Write a program in Arduino to I/O interface with putty.sh.
13.	Write a program in Arduino to interface LED and create a burglar alarm.
14.	Write a program in Arduino to interface with a dc motor.
	Innovative
1.	8255 Interface to 8051.
2.	Traffic Light Controller interface to 8051.
3.	Interfacing Arduino IDE to create an IOT data log.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

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

10. Course Outcomes:

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

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

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

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

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

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

11.Details of Course:

Unit No.	Contents	Contact Hours
1.	**Fundamental Of Vibrations:** Definition of Vibration, Causes of Vibration, Effects of Vibration, Nomenclature, Vector Method of representing harmonic motions, Additions of simple harmonic motions (Problems), Beats Phenomenon (Problems), Complex Method of representing harmonic 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 equation (Newton's Method, Energy Method, Rayleigh's Method,	08

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	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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NAME OFDEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TME 702**
2. CourseTitle: **COMPUTER AIDED DESIGN AND MANUFACTURING**
3. ContactHours: **L:3** **T: 0** **P: 0**
4. ExaminationDuration(Hrs.): **Mid** 1.5 **End** 3
5. RelativeWeightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.**Semester**:VII** **8.** Subject Area**:CC**
9. Pre-requisite**: Design, Manufacturing**

10. Course Outcomes:

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

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

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

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

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

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

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11.Details ofCourse:

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 and3 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: Advantages of GT.Computer Aided Process Planning: Introduction and benefits of CAPP. Types of CAPP system, Flexible Manufacturing System (FMS) its advantages, components of a FMS system, Introduction to Manufacturing Execution System (MES)	**07**
4.	Introduction to Automation and need and future of NC systems and CAM. Advantages&disadvantages. Classification. Open and closed loop systems. Historical development and future trends. Difference between ordinary and NC machine tools. Methods for improving Accuracy and Productivity.	**07**
5.	NC Part Programming- (a) Manual (word address format) programming. Examples Drilling Robotics- NC machine vs Robots. Types and generations of Robots. Robot applications. Economics, Introduction to Artificial Intelligence for Intelligent manufacturing.	**07**
	Total	**35**

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12.SuggestedBooks:

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 OFDEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TRA703**

2. CourseTitle: **MECHATRONICS**

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

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

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

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

9.Pre-requisite**:** **Basics of Electrical and Electronics**

10. Course Outcome:

Course Outcome 1: Understand different techniques of signal processing.

Course Outcome 2: Understand several types of actuators used in mechatronic systems.

Course Outcome 3: Understand several types of sensors used in mechatronic systems.

Course Outcome 4: Understand microprocessor and microcontrollers.

Course Outcome 5: Develop mathematical models of mechatronic systems.

11.Details ofCourse:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION AND SIGNAL PROCESSING:** Definition of mechatronics, components of a mechatronic system, applications. Introduction to signal processing, different types of amplifiers, operational amplifiers, signal conditioning, pulse modulation, digital signal filtering, multiplexing, data acquisition, analog-to digital and digital-to-analog conversion.	**08**
2.	**ACTUATORS:** Introduction to different types of actuators, AC and DC motors, stepper motors, solenoids and relays, control valves, hydraulic and pneumatic systems, piezoelectric actuators, shape memory alloy.	**07**

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3.	**SENSORS:** Introduction to different types of sensors and transducers, linear and rotational sensors, force, torque, stress and strain sensors, temperature sensors, pressure and flow sensors, piezoelectric accelerometer, proximity, light and laser sensors, selection of sensors	**07**
4.	**MICROCONTROLLER AND MICROPROCESSOR:** Structure of microcomputers, power supply, programmable logic controller, microprocessor and microcontroller applications.	**07**
5.	**MODELING:** Introduction to system mathematical modeling, transfer function, block diagram, modeling of mechanical, electrical, and fluid system, modeling of mechatronic systems: dc motor, robotic manipulator.	**07**
	Total	**36**

12.SuggestedBooks:

S. No.	Name of Authors /Books /Publisher
1.	Alciatore, D. G., Histand, M. B., & Alciatore, D. G. (2007). *Introduction to mechatronics andmeasurement systems*. Tata McGraw-Hill Education.
2.	Ganesh, R. N., (2011) *Intelligent mechatronics*. InTech.
3.	Bishop, R. H. (Ed.). (2005). *Mechatronics: an introduction*. CRC Press.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TRA 704**
2. Course Title: **HYDRAULIC & PNEUMATIC SYSTEMS**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 3 **7.** Semester: **VII** **8.** Subject Area: **CC**
9. Pre-requisite: **Nil**

10.Details of Course:

Unit No.	Contents	Contact Hours
1.	**BASIC CONCEPT & PROPERTIES** Fluid - 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** Fluid 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**	09

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	Viscous flow-Navier- Stroke's equation (Statement only) - Shear stress, pressure gradient relationship laminar flow between parallel plates - Laminar 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 & FANS** Impact 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:

S. 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

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

1. Subject Code: **TAE 713**
2. Course Title: **TRIBOLOGY**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: 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.

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11.Details of Course:

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

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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 OFDEPARTMENT: **Department of Mechanical Engineering**

1. LabCode: **PME 711**
2. CourseTitle: **AUTOMATION AND CNC LAB**
3. ContactHours: **L:0** **T: 0** **P: 3**
4. ExaminationDuration(Hrs.): **Mid** 3 **End** 3
5. RelativeWeightage: **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.

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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 pick and place operation. (Only for Demo)
14. 6 -Axis Robot programming to perform welding operation.

REFERENCE:

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

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

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

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

1. Subject Code: **TME 802**
2. Course Title: **POWER PLANT ENGINEERING**

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

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

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

6. Credits**:** 4 **7.** Semester**: 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.	Introduction: Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion, calculations. Variable Load problem Industrial production and power generation compared, ideal and realized load curves, terms and factors. Effect of variable load on power plant operation, methods of meeting the	08

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	variable load problem. Power plant economics and selection Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.	
2.	Steam power plant: Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories. General layout of steam power plant. Different systems such as fuel handling system, pulverizes and coal burners, combustion system, draft, ash handling system, feed water treatment and condenser and cooling system, turbine auxiliary systems such as governing, feed heating, boiler-heating , flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency.	**08**
3.	Diesel power plant: General layout, performance of diesel engine, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance. s turbine power plant: Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, combined cycle power plants.	**10**
4.	Hydro electric station: Principles of working, applications, site selection, classification and arrangements, hydroelectric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems.	**08**
5.	Nuclear power plant: Principles of nuclear energy, basic components of nuclear reactions, nuclear power station ,Nuclear fuels in fission and fusion reactors, fissile and fertile materials, Neutron chain reaction in fission reactors, Neutron flux, Concept of reactors ,types of Reactors Coolants, moderators, Control and structural materials.	**08**
	Total	**42**

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12.Suggested Books:

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.

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GRAPHIC ERA (DEEMED TO BE UNIVERSITY), DEHRADUN

NAME OFDEPARTMENT: **Department of Mechanical Engineering**

1. SubjectCode: **TME 811**
2. CourseTitle: **COMPUTER INTEGRATED MANUFACTURING**

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

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

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

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

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

10. Course Outcomes:

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

Course Outcome 2: To understand components of CIM.

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

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

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

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

11.Details ofCourse:

Unit No.	Contents	Contact Hours
1.	**INTRODUCTION TO CIM** Concept of Computer Integrated Manufacturing (CIM); Basic components of CIM; Distributed database system; distributed communication system, computer networks for manufacturing; future automated factory; social and economic factors; concurrent engineering; limitations of CIM.	08

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

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12.SuggestedBooks:

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

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

1. Subject Code: **TME 812**
2. Course Title: **NON-CONVENTIONAL ENERGY RESOURCES**
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage: **MSE** 25 **ESE** 50 **TSM** 25
6. Credits: 3 **7.** Semester: **VIII** **8.** Subject Area: **DE**
9. Pre-requisite: **Nil**

10. Course Outcomes:

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

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

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

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

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

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

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11.Details of Course:

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

12.Suggested Books:

No.	Name of Authors /Books /Publisher
1.	Energy Management and condevtion, by Clive Beggs,Butterwoth- Heinemann Elsevier Science.
2.	Optimising Energy Efficiency in the Industry, By Rajan, Tata Mc Graw Hill Publishers.

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3.	Renewable Energy Sources and their Environment Impact, byAbbasi&Abbasi, Prentice Hall of India.
4.	Ashok V. Desai, "Nonconventional Energy", New Age Internantional Publishers Ltd.

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

1. Subject Code: **UCE 801**
2. Course Title : DISASTER MANAGEMENT
3. Contact Hours: **L: 3** **T: 0** **P: 0**
4. Examination Duration (Hrs.): **Mid** 1.5 **End** 3
5. Relative Weightage**: MSE** 25 **ESE** 50 **TSM** 25
6. Credits**:** 3 **7.** Semester**: VIII** **8.** Subject Area**: General Course**

9.Details of Course:

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

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

12.Suggested Books:

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

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PRA 811 **Product design and development Lab**

OBJECTIVE:

- To impart knowledge on the use of various media such as clay, wood and RP techniques for development of prototypes

OUTCOME: Upon conclusion of this course the student will be able to

- appreciate the use of physical prototype models for evaluating product concept
- apply theoretical knowledge to design and development of physical products using clay, wood, sheet metal and RP techniques
- Select an appropriate product design and development process for a given application
- Develop the methods to minimise the cost.

The students in a group have to develop digital and physical prototype models using RP machine / clay models of a new product/ existing product with enhanced feature involving the following areas:

- Automotive components
- Tool and die components
- Press tool components
- Consumer product
- Injection moulded products.

The fabricated models may be in the form of RP models, clay models, sheet metal models or cardboard models etc… The design and development of the product will be reviewed in two stages for awarding internal marks. The end semester examination mark will be based on the demonstration of the new product developed and oral examination on the same by internal examiners.

TOTAL: 30 PERIODS