

## SCHEME OF EXAMINATION

and

SYLLABI

for

**Bachelor of Technology  
Mechanical Engineering**

Offered by

**University School of Engineering and Technology**

**1<sup>st</sup> SEMESTER TO 8<sup>th</sup> SEMESTER**



**Guru Gobind Singh Indraprastha University  
Dwarka, Delhi – 110078 [INDIA]**

[www.ipu.ac.in](http://www.ipu.ac.in)

**BACHELOR OF TECHNOLOGY  
(COMMON TO ALL BRANCHES)  
FIRST SEMESTER EXAMINATION**

Code No.	Paper ID	Paper	L	T/P	Credits	Status
<b>THEORY PAPERS</b>						
ETMA-101		Applied Mathematics-I	3	1	4	M
ETPH-103		Applied Physics-I	2	1	3	M
ETME-105		Manufacturing Processes	3	0	3	M
ETEE-107		Electrical Technology	3	0	3	M
ETHS-109		Human Values and Professional Ethics-I#	1	1	1	--
ETCS-111		Fundamentals of Computing	2	0	2	--
ETCH-113		Applied Chemistry	2	1	3	M
<b>PRACTICAL/VIVA VOCE</b>						
ETPH-151		Applied Physics Lab-I	-----	2	1	
ETEE-153		Electrical Technology Lab	-----	2	1	M
ETME-155		Workshop Practice	-----	3	2	M
ETME-157		Engineering Graphics Lab	-----	3	2	
ETCS-157		Fundamentals of Computing Lab	-----	2	1	--
ETCH-161		Applied Chemistry Lab	-----	2	1	--
		NCC/NSS*#	-----	-----	-----	--
<b>TOTAL</b>			<b>16</b>	<b>18</b>	<b>27</b>	

M: Mandatory for award of degree

#NUES (Non University Examination System)

\*#NCC/NSS can be completed in any one semester from Semester 1 – Semester 4. It will be evaluated internally by the respective institute. The credit for this will be given after fourth Semester for the students enrolled from the session 2014-15 onwards. The camps/classes will be held either during Weekends/Holidays or Winter/Summer Vacations.

**BACHELOR OF TECHNOLOGY  
(COMMON TO ALL BRANCHES)  
SECOND SEMESTER EXAMINATION**

Code No.	Paper ID	Paper	L	T/P	Credits	Status
<b>THEORY PAPERS</b>						
ETMA-102		Applied Mathematics-II	3	1	4	M
ETPH-104		Applied Physics-II	2	1	3	
ETEC-106		Electronic Devices	3	0	3	M
ETCS-108		Introduction to Programming	3	0	3	M
ETME-110		Engineering Mechanics	2	1	3	--
ETHS-112		Communication Skills	2	1	3	--
ETEN-114		Environmental Studies	2	1	3	--
<b>PRACTICAL/VIVA VOCE</b>						
ETPH-152		Applied Physics Lab-II	-----	2	1	
ETCS-154		Programming Lab	-----	2	1	M
ETEC-156		Electronic Devices Lab	-----	2	1	M
ETME-158		Engineering Mechanics Lab	-----	2	1	--
ETEN-160		Environmental Studies Lab	-----	2	1	--
		NCC/NSS*#	-----	-----	-----	--
<b>TOTAL</b>			<b>17</b>	<b>15</b>	<b>27</b>	

M: Mandatory for award of degree

#NUES (Non University Examination System)

\*#NCC/NSS can be completed in any one semester from Semester 1 – Semester 4. It will be evaluated internally by the respective institute. The credit for this will be given after fourth Semester for the students enrolled from the session 2014-15 onwards. The camps/classes will be held either during Weekends/Holidays or Winter/Summer Vacations.

**BACHELOR OF TECHNOLOGY  
(MECHANICAL ENGINEERING)  
THIRD SEMESTER EXAMINATION**

Code No.	Paper ID	Paper	L	T/P	Credits	Status
<b>THEORY PAPERS</b>						
ETMA-203		Numerical Analysis and Statistical Techniques	3	1	4	M
ETME-209		Electrical Machines	3	0	3	
ETME-203		Thermal Science	3	1	4	M
ETME-205		Production Technology	3	1	4	M
ETME-207		Material Science and Metallurgy	3	0	3	
ETME-211		Strength of Materials-I	3	1	4	M
<b>PRACTICAL/VIVA VOCE</b>						
ETMA-253		Numerical Analysis and Statistical Techniques Lab	0	2	1	
ETME-253		Electrical Machines Lab	0	2	1	
ETME-255		Production Technology Lab	0	2	1	
ETME-257		Strength of Materials-I Lab	0	2	1	
ETTE-259		Machine drawing lab	0	3	2	
		<b>NCC/NSS*</b>	-	-	-	
<b>TOTAL</b>			<b>18</b>	<b>15</b>	<b>28</b>	

*M: Mandatory for the award of degree.*

*\*NCC/NSS can be completed in any one semester from Semester 1 – Semester 4. It will be evaluated internally by the respective institute. The credit for this will be given after fourth Semester for the students enrolled from the session 2014-15 onwards.*

**BACHELOR OF TECHNOLOGY  
(MECHANICAL ENGINEERING)  
FOURTH SEMESTER EXAMINATION**

Code No.	Paper ID	Paper	L	T/P	Credits	Status
<b>THEORY PAPERS</b>						
ETME-202		Kinematics of Machines	3	1	4	M
ETME-204		Strength of Materials-II	3	1	4	M
ETME-206		Manufacturing Machines	3	1	4	M
ETME-208		Measurements and Instrumentation	3	0	3	
ETME-210		I.C Engines and Gas Turbine	3	1	4	
ETME-212		Fluid Mechanics	3	1	4	M
<b>PRACTICAL/VIVA VOCE</b>						
ETME-252		Kinematics of Machines Lab	0	2	1	
ETME-254		Strength of Material Lab-II	0	2	1	
ETME-256		Manufacturing Machines Lab	0	2	1	
ETME-258		I.C. Engines and Gas Turbine lab	0	2	1	
ETME-260		Fluid Mechanics Lab	0	2	1	
ETSS-250		NCC/NSS*	-	-	1	
<b>TOTAL</b>			<b>18</b>	<b>15</b>	<b>29</b>	

*M: Mandatory for the award of degree.*

*\*NCC/NSS can be completed in any one semester from Semester 1 – Semester 4. It will be evaluated internally by respective institute. The credit for this will be given after fourth Semester for the students enrolled from the session 2014-15 onwards.*

**NOTE:** 4 weeks Industrial / In-house Workshop will be held after fourth semester. However, Viva-Voce will be conducted in the fifth semester.

**BACHELOR OF TECHNOLOGY  
(MECHANICAL ENGINEERING)  
FIFTH SEMESTER EXAMINATION**

Code No.	Paper ID	Paper	L	T/P	Credits	Status
<b>THEORY PAPERS</b>						
ETME-301		Management of Manufacturing Systems	3	0	3	
ETME-303		Heat Transfer	3	1	4	M
ETME-305		Dynamics of Machines	3	1	4	M
ETME-307		Machine Design - I	3	1	4	
ETEL-307		Control Systems	3	1	4	
ETHS-301		Communication Skills for Professionals	2	0	1	
<b>PRACTICAL/VIVA VOCE</b>						
ETME-351		Heat Transfer Lab	0	2	1	
ETME-353		Dynamics of Machines Lab	0	2	1	
ETME-355		Machine Design - I Lab	0	3	2	
ETEL-355		Control Systems Lab	0	2	1	
ETHS-351		Communication Skills for Professionals Lab	0	2	1	
ETME-361		Industrial Training/In-House*	0	0	1	
<b>TOTAL</b>			<b>17</b>	<b>15</b>	<b>27</b>	

*M: Mandatory for the award of degree.*

\*Viva-Voce for evaluation of Industrial Training / In-house Workshop will be conducted in this semester.

**Note:** Minimum of 2 weeks of In-house training related to ME will be held after 5<sup>th</sup> semester; however, viva-voce will be conducted in 6<sup>th</sup> Semester (ETME 362).

**BACHELOR OF TECHNOLOGY  
(MECHANICAL ENGINEERING)  
SIXTH SEMESTER EXAMINATION**

Code No.	Paper ID	Paper	L	T/P	Credits	Status
<b>THEORY PAPERS</b>						
ETME-302		Machine Design-II	3	1	4	M
ETME-304		Metal Cutting and Tool Design	3	1	4	M
ETME-306		Fluid Systems	3	1	4	
ETME-308		Refrigeration and Air conditioning	3	1	4	M
ETMS-310		Organizational Behaviour	3	0	3	
ETME-312		Metrology	3	0	3	
<b>PRACTICAL/VIVA VOCE</b>						
ETME-352		Machine Design-II Lab	0	3	2	
ETME-354		Metal Cutting and Tool Design Lab	0	2	1	
ETME-356		Fluid Systems Lab	0	2	1	
ETME-358		Refrigeration and air conditioning Lab	0	2	1	
ETME-360		Metrology Lab	0	2	1	
ETME-362		In-house training (two weeks)	0	0	1	
<b>TOTAL</b>			<b>18</b>	<b>15</b>	<b>29</b>	

M: Mandatory for award of degree

**Note:** Minimum of 4-6 weeks of industrial training related to ME will be held after 6<sup>th</sup> semester; however, viva-voce will be conducted in 7<sup>th</sup> Semester (ETME 461).

**Imp:-** Elective Paper will be floated in 7<sup>th</sup> Semester, if one-third of the total students opt for the same. It is advised that the decision about the elective subject for 7<sup>th</sup> Semester is done before the 15<sup>th</sup> April every year before end of 6<sup>th</sup> semester.

**BACHELOR OF TECHNOLOGY  
(MECHANICAL ENGINEERING)  
SEVENTH SEMESTER EXAMINATION**

Paper Code	Paper ID	Paper	L	T/P	Credits
<b>THEORY PAPER</b>					
ETME-401		Automobile Engineering	3	0	3
ETME-403		Computer Integrated Manufacturing	3	0	3
ETME-405		Power Plant Engineering	3	0	3
<b>ELECTIVE-I(CHOOSE ANY ONE)</b>					
ETME-407		Optimization Techniques	3	0	3
ETME-409		Preventive Maintenance and Condition Monitoring	3	0	3
ETCS-411		Introduction to Data Science	3	0	3
ETME-413		Non-conventional manufacturing processes	3	0	3
ETME-415		Geometric Modelling and Product Design	3	0	3
ETME-417		Advanced Material Science and Metallurgy	3	0	3
ETMT-427		Operations Research	3	0	3
ETCS-425		Database Management Systems	3	0	3
<b>ELECTIVE-II(CHOOSE ANY ONE)</b>					
ETEE-419		Renewable Energy Resources	3	0	3
ETME-421		Management Information System and ERP	3	0	3
ETME-423		Finite Element Methods	3	0	3
ETAT-403		Mechatronics	3	0	3
ETME-427		Rotor Dynamics	3	0	3
ETCS-429		Artificial Intelligence	3	0	3
ETME-411		Computational Fluid Dynamics	3	0	3
ETHS-419		Sociology and Elements of Indian History for Engineers	3	0	3
<b>PRACTICAL/VIVA VOCE</b>					
ETME451		Automobile Engineering Lab	0	2	1
ETME453		Computer Integrated Manufacturing Lab	0	2	1
ETME455		Lab Based on Elective- I or II	0	2	1
ETME457		Minor Project+	0	6	3
ETME459		Seminar (topic should be linked to industrial training/ Soft skills learnt) <sup>#</sup>	0	2	1
ETME461		Industrial Training	0	0	1
<b>TOTAL</b>			<b>15</b>	<b>14</b>	<b>23</b>

**Imp:-** Elective Paper will be floated if one-third of the total students opt for the same. It is advised that the decision about the elective subject for 8<sup>th</sup> Semester is done before the 15<sup>th</sup> November every year before end of seventh semester. New Electives may be added as per requirement after getting it duly approved by BOS and AC respectively.

+ The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format, thereafter he/she will have to present the progress of the work through seminars and progress reports.

#NUES (Non University Examination System)



**BACHELOR OF TECHNOLOGY  
(MECHANICAL ENGINEERING)  
EIGHTH SEMESTER EXAMINATION**

Code No.	Paper ID	Paper	L	T/P	Credits
<b>THEORY PAPERS</b>					
ETME-402		Engineering System Modelling and Simulation	3	1	4
ETME-404		Statistical Quality Control and Reliability	3	0	3
ETHS-402		Human Values and Professional Ethics-II	1	0	1
<b>ELECTIVE-III (CHOOSE ANY ONE)</b>					
ETME-408		Nuclear Power Generation and Supply	3	0	3
ETMT-402		Robotics	3	0	3
ETME-412		Rapid prototyping	3	0	3
ETME-416		Mechanical Vibrations	3	0	3
ETIT-410		Soft Computing	3	0	3
ETEC-420		Data Communication and Networks	3	0	3
<b>ELECTIVE-IV# (CHOOSE ANY ONE)</b>					
ETME-422		Gas Dynamics	3	0	3
ETME-424		Cryogenic Engineering	3	0	3
ETME-426		Total Quality Management	3	0	3
ETTE-424		Supply Chain Management-Planning	3	0	3
ETME-432		Turbo Machinery	3	0	3
<b>PRACTICAL</b>					
ETME-452		Engineering System Modelling and Simulation	0	2	1
ETME-454		Statistical Quality Control and Reliability Lab	0	2	1
ETME-456		Lab Based on Elective III or IV	0	2	1
ETME-458		*Major project	0	12	8
<b>TOTAL</b>			<b>13</b>	<b>19</b>	<b>25</b>

\*The student will submit a synopsis at the beginning of the semester for approval from the departmental committee in a specified format, thereafter he/she will have to present the progress of the work through seminars and progress reports. Seminar related to major project should be delivered one month after starting of Semester. The progress will be monitored through seminars and progress reports.

#Elective Paper will be floated if one-third of the total students opt for the same. It is advised that the decision about the elective subject is done before the 15<sup>th</sup> November every year before end of seventh semester. New Electives may be added as per requirement after getting it duly approved by BOS and AC respectively.

**NOTE:**

1. The total number of the credits of (Mechanical) Programme are = 215.
2. Each student shall be required to appear for examinations in all courses. However, for the award of the degree a student shall be required to earn minimum of 200 credits including Mandatory papers (M).

**FOR LATERAL ENTRY STUDENTS:**

1. The total number of the credits of the B.Tech. (Mechanical) Programme = 161.
2. Each student shall be required to appear for examinations in all courses Third Semester onwards. However, for the award of the degree a student shall be required to earn the minimum of 150 credits, including mandatory papers (M).

**NOMENCLATURE OF CODES GIVEN IN THE SCHEME OF****B.TECH AND M.TECH**

1. **ET** stands for Engineering and Technology.
2. **PE** stands for Power Engineering.
3. **ME** stands for Mechanical Engineering.
4. **MT** stands for Mechatronics.
5. **AT** stands for Mechanical and Automation Engineering.
6. **EE** stands for Electrical and Electronics Engineering.
7. **EL** stands for Electrical Engineering.
8. **IT** stands for Information Technology
9. **CS** stands for Computer Science and Engineering
10. **CE** stands for Civil Engineering
11. **EC** stands for Electronics and Communications Engineering.
12. **EN** stands for Environmental Engineering
13. **TE** stands for Tool Engineering
14. **MA** stands for Mathematics
15. **HS** stands for Humanities and Social Sciences
16. **SS** stands for Social Services

**NUMERICAL ANALYSIS & STATISTICAL TECHNIQUES**

<b>Paper Code: ETMA-203</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Numerical Analysis &amp; Statistical Techniques</b>	<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**Maximum Marks: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks.

***Objective:** To develop numerical ability and to impart knowledge in Statistical methods and Probability theory and their applications in Engineering to enable them to apply that for solving real world problems.*

**UNIT I**

Probability Theory: conditional probability, Baye's theorem, Random variable: discrete probability distribution, continuous probability distribution, expectation, moments, moment generating function, skewness, kurtosis, binomial distribution, Poisson distribution, normal distribution, Curve Fitting: Principle of least square Method of least square and curve fitting for linear and parabolic curve .

**[T1,T2][No. of Hrs. 11]**

**UNIT II**

Correlation Coefficient, Rank correlation, line of regressions and properties of regression coefficients, ANOVA, Sampling distribution: Testing of hypothesis, level of significance, sampling distribution of mean and variance, Chi-square distribution, Student's T- distribution, F- distribution, Fisher's Z- distribution.

**[T1,T2][No. of Hrs. 11]**

**UNIT III**

Numerical Methods: Solution of algebraic and transcendental equations using bisection method, Regula-Falsi method and Newton – Raphson method. Solution of linear simultaneous equations using Gauss-Jacobi's iteration method and Gauss-Seidal's iteration methods. Finite differences: Forward differences, backward differences and Central differences. Interpolation: Newton's interpolation for equi-spaced values. Stirling's central difference interpolation formula, Divided differences and interpolation formula in terms of divided differences, Lagrange's interpolation formula for unequi-spaced values.

**[T1,T2][No. of Hrs. 11]**

**UNIT IV:**

Numerical Differentiation, maxima and minima of a tabulated function. Numerical Integration: Newton-Cote's quadrature formula, Trapezoidal rule, Simpson's one-third rule and Simpson's three-eighth rule .Numerical solution of ordinary differential equations: Picard's method, Taylor's method, Euler's method, modified Euler's method, Runge-Kutta method of fourth order.

**[T1,T2][No. of Hrs. 11]**

**Text Books:**

- [T1] R.K. Jain and S.R.K. Iyengar, "Numerical methods for Scientific and Engineering Computation", NewAge.
- [T2] N.M. Kapoor, "Fundamentals of Mathematical Statistics", Pitambar Publications

**Reference Books:**

- [R1] E. kresyzig, "Advance Engineering Mathematics", Wiley publications
- [R2] P. B. Patil and U. P. Verma, " Numerical Computational Methods", Narosa
- [R3] Partial Differential Equations "Schaum's Outline Series", McGraw Hill.
- [R4] Michael Greenberg, "Advance Engineering mathematics", Pearson.
- [R5] Schaum's Outline on Fourier Analysis with Applications to Boundary Value Problem, TMH
- [R6] B.S. Grewal., "Numerical Methods in Engg. And Science", Khanna Publications.
- [R7] Miller and Freund, "Probability and statistics for Engineers", PHI
- [R8] Gupta and Kapoor, "Fundamentals of Mathematical Statistics" Sultan Chand and Sons.

**ELECTRICAL MACHINES**

**Paper Code: ETME-209**  
**Paper: Electrical Machines**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: Providing sound knowledge about the principles of operation of various electrical machines, their constructional features, and their behavior and characteristics under various condition of operation.*

**UNIT – I**

**D.C. Machines:** Constructional features, Principles of operation, EMF equation Voltage build up phenomenon in a D.C. shunt generator, characteristics of different types of generators. Principle of operation of DC motor, back emf, speed and torque equation, various characteristics of different motors, starters and speed control of DC motors, applications of DC generators and motors.

**[T1, T2][No. of Hrs. 10]****UNIT – II**

**A.C. Machines:** Constructional features, concept of revolving magnetic field, and principle of operation of Three phase induction motors, torque slip characteristics and power flow in induction motors, induction motor as a transformer, equivalent circuit, performance calculations, starting and speed control.

**[T1, T2][No. of Hrs. 10]****UNIT – III**

**Three Phase synchronous Machine:** Constructional features EMF equation. Armature reaction of synchronous generator, voltage regulation of generators, phasor diagrams and equivalent circuits of synchronous machine, computation of synchronous machine performance. Starting methods and principle of operation of synchronous motors, synchronous condenser.

**[T1, T2][No. of Hrs. 11]****UNIT – IV**

**Single phase induction motors:** double revolving field theory, different types of single phase induction motors, characteristics and typical applications. Stepper motors, hysteresis motor, Servo motors, AC series motor and Universal motor and their applications to mechanical systems.

**[T1, T2][No. of Hrs. 10]****Text Books:**

- [T1] Electric Machinery, A Fitzgerald, Charles Kingsley, Stephen Umans, Tata McGraw Hill Education, 6<sup>th</sup> edition, 2002  
 [T2] Electrical Machines, D P Kothari, I.J. Nagrath by Tata McGraw Hill Education, 2014

**Reference Books:**

- [R1] Electrical and Electronic Technology, Hughes Edward, Ian Mckenzie Smith, JohnHiley, Pearson Education, 10<sup>th</sup> edition, 2010  
 [R2] Electrical Engineering Fundamentals, Vincent Del Toro, Prentice-Hall, 2<sup>nd</sup> edition, 1989  
 [R3] Introduction to Electrical Engineering, Mulukutla S. Sarma, Oxford University Press Inc., 2001  
 [R4] Problems in Electrical Engineering: Power engineering and electronics with answers Partly Solved in S.I. Units: Parker Smith , CBS Publishers, 9<sup>th</sup> edition, 2003  
 [R5] Basic Electrical Engineering, C.L.Wadhwa, New Age International, 2007.

**THERMAL SCIENCE****Paper Code: ETME-203****Paper: Thermal Science**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTION TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to introduce basic concepts, thermodynamics and other concepts related to thermal science.*

**UNIT – I**

**Basic concepts:** Introduction to the Basic definitions of Engineering Thermodynamics. Thermodynamic systems : Closed, Open and Isolated systems. Microscopic and Macroscopic view. Intensive and Extensive properties. Zero<sup>th</sup> law of Thermodynamics. Phase, State, Process, Cycle. Point functions and Path functions. Gas Laws and Equation of State. Work and Heat.

**First Law of Thermodynamics:** Introduction to First Law of Thermodynamics, Internal energy. Non flow processes, p-v diagrams. Concept of Flow work, Enthalpy. Analysis of steady flow and unsteady flow processes and their applications. Throttling process.

**Second Law of Thermodynamics:** Limitations of First law and necessity of Second Law of Thermodynamics, Kelvin Planck statement and Clausius statement, Reversible and Irreversible processes. Carnot cycle, Reversed Carnot cycle. Carnot's Theorem, Clausius inequality. Entropy, Change in Entropy during various processes and representations on t-s diagrams, Entropy principle, Entropy Generation.

**[T1, T2, T3, R1, R2, R3] [No. of Hrs. 12]****UNIT – II**

**Availability and Irreversibility :** High grade and low grade energy. Available and unavailable energy. Dead state. Loss of available energy due to Heat transfer through a Finite temperature difference. Availability. Reversible work and Irreversibility. Availability in non flow systems and steady flow systems. Second law efficiency.

**Thermodynamic Property Relations:** Maxwell Relations. Clapeyron Equation.

**Properties of a Pure Substance:** Phase equilibrium of a pure substance on t-v diagram. Normal boiling point of a Pure substance. Saturation states. Compressed liquid. p-v & p-t diagram of a pure substance. Saturated steam, Dry and saturated steam, Superheated steam. Use of Steam tables and Mollier diagram. Different processes of vapour on p-v and t-s diagrams. Measurement of Dryness fraction.

**[T1, T2, T3, R1, R2, R3] [No. of Hrs. 12]****UNIT - III:**

**Vapour Power Cycles :** Carnot cycle. Simple Rankine cycle. Effect of various parameters on the efficiency of Rankine cycle. Reheat and Regenerative cycles.

**[T1, T2, T3, R1, R2, R3] [No. of Hrs. 10]****UNIT – IV**

**Gas Power Cycles:** Carnot cycle, Otto cycle, Diesel cycle, Dual cycle, Stirling cycle, and Ericsson cycle.

**Gas Turbines:** Brayton cycle, Thermal refinements. Performance of Gas turbines, Combined cycle. Principles of Jet Propulsion. Turbojet and Turbo-prop engines, Rocket engines.

**[T1, T2, T3, R1, R2, R3] [No. of Hrs. 10]****Text Books:**

- [T1] P.K. Nag, "Engineering Thermodynamics", 5<sup>th</sup> edition McGraw Hill  
 [T2] Y. A. Cengel & M. A Boles "Thermodynamics- An Engineering Approach", 7th edition TMH  
 [T3] Gordon Rosers, & Yon Mahew; "Engineering Thermodynamics", Pearson.

**Reference books:**

- [R1] M.J. Moran & H.N. Shapiro "Fundamentals of Thermal Engineering" John Wiley & sons.  
 [R2] C. P. Arora " Thermodynamics", McGraw Hill  
 [R3] S L Somasundaram "Engineering Thermodynamics", New Age International Publishers.  
 [R4] R. K. Rajput, "Engineering Thermodynamics", Lakshmi Publications  
 [R5] Shiv Kumar, " Fundamentals of Thermal Engineering" Ane Books Pvt. Ltd.

**PRODUCTION TECHNOLOGY**

**Paper Code: ETME-205**

**Paper: Production Technology**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: The objective of the paper is to facilitate the student with conventional techniques being used in industry for production purposes.*

**UNIT - I**

**Moulding:** Introduction to sand moulding, Pattern design, Pattern layout and construction, testing of moulding sand. moulding and core making machines, CO<sub>2</sub> - Process, fluid sand process, shell moulding, cold curing process, hot-box method, flask less moulding, Design of metal moulds, Die Design for die Casting.

**[T1] [No. of Hrs: 10]**

**UNIT - II**

**Casting:** Directional principles, Solidification, types of gating systems, Pouring time and temperature. Design criteria of pouring basin, sprue, runner, gate and riser, gating ratio- related numerical problems, Use of chaplet, chills and padding, Selection of melting furnaces, Crucible furnaces, Electric furnaces, Induction furnace, Control of melt and Cupola charge calculations. Foundry mechanization and layout.

**[T1,T2] [No. of Hrs: 10]**

**UNIT - III**

**Welding:** Principle, advantages, limitations and applications, Tungsten Inert Gas welding, Metal Inert Gas welding, Electro - slag welding, Electro - Gas Welding, Explosive Welding, Ultrasonic Welding, Electron Beam Welding, Laser Beam Welding, Friction Welding, Cold Welding, Thermit Welding. Welding Defects-causes and remedies. Numerical problems on electric arc welding and resistance welding.

**[T1,T2][No. of Hrs: 11]**

**UNIT - IV**

**Metal Forming:** Introduction to Metal Forming, Elastic & plastic deformation, Hot working and cold working. Work required for forging, Hand, Power, Drop forging.

Analysis of wire drawing and maximum reduction. Tube drawing, Extrusion, types and its application. Rolling process, rolling mills & rolled-sections. Defects in metal forming processes. Sheet metal processes, shearing, calculation of punch force, shearing dies, stretch forming, Deep drawing and its analysis.

**[T1,T2] [No. of Hrs: 11]**

**Text Books:**

[T1] Manufacturing processes Vol. 1, by H.S. Shan, Pearson Education

[T2] Manufacturing Engineering & Technology by Kalpakjian, Pearson Publication

**Reference Books:**

[R1] Mikell P. Groover" Principles of Modern Manufacturing, 5th Edition SI Version , Wiley

[R2] Jain P.L., "Principles of Foundry Technology", Tata McGraw Hill, New Delhi, 1998.

[R3] Sharma P.C., "A Text Book of Production Engineering", Vol.1, S. Chand Publication, New Delhi, 2001.

[R4] Heine & Rosenthal, "Principle of Metal Casting", Tata McGraw Hills, New Delhi, 2003.

[R5] Little Richard L, "Welding & Welding Technology", Tata McGraw Hill, New Delhi, 2003.

[R6] Jain, R.K., "Production Technology", Khanna Publishers, 2001.

[R7] HMT Bangalore, "Production Technology", Tata McGraw Hill, 1980.

[R8] A.K. Chakrabarti "Casting Technology and cast alloys" 2011, PHI learning



**MATERIAL SCIENCE & METALLURGY****Paper Code: ETME-207****Paper: Material Science & Metallurgy**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: The objective of the paper is to introduce the student about knowledge of structure of materials and effect of deformation. This paper also provides understanding of heat treatment on materials and applications of different types of alloys and composite materials.*

**UNIT – I**

**Structure of metal:** Crystal structure (BCC, FCC and HCP, Packing factor and density calculation), X-ray diffraction, miller indices, lattices, imperfections, elementary treatment of point and line defects and their relation to mechanical properties.

**Diffusion:** Diffusion mechanisms, steady state and non steady state diffusion, factors affecting diffusion

**Deformation:** Slip, twinning, effect of cold and hot working on mechanical properties, principles of recovery, re-crystallization and grain growth.

**[T1,T2] [No. of Hrs. 11]****UNIT – II**

**Fracture:** Types of fracture ductile and brittle, fatigue

**Creep:** Basic consideration in the selection of material for high and low temperature service, creep curve, effect of material variables on creep properties, brittle failure at low temperature.

**Solidification:** Phases in metal system, lever rule, solidification of metal and alloys, solid solution, eutectic, eutectoid and inter-metallic compounds, Iron carbon equilibrium diagram, TTT-diagram. Effect of alloying elements on TTT diagram, S-N curve.

**[T1,T2][No. of Hrs. 13]****UNIT - III**

**Heat Treatment:** Principles and purpose of heat treatment of plain carbon steels, annealing, normalizing, hardening, tempering, isothermal treatment, case hardening – carburizing, nitriding etc, precipitating hardening of aluminum alloys. Hardenability: determination of hardenability Jominy end quench test.

**Materials:** Plain Carbon steels, effect of alloying elements, properties, uses, springs, and wear resisting steels, IS standards codes for steels.

**[T1,T3][No. of Hrs: 10]****UNIT - IV**

**Corrosion:** Types of corrosion, Galvanic cell, rusting of Iron, Methods of protection from corrosion.

**Fiber Reinforced Composites:** General characteristics, Applications, Introduction to Fibers – glass, carbon, Kevlar 49 fibers. Matrix – Polymeric, Metallic, Ceramic Matrix, Coupling agents and fillers.

**[T1,T3][No. of Hrs: 10]****Text Books:**

[T1] Callister “Materials Science and Engineering”: An Introduction, 6th Edition

[T2] Parashivamurthy K.I “Material Science and Metallurgy”, Pearson,

[T3] Sidney H Avner,” Introduction to Physical Metallurgy”, Tata McGraw-Hill,New Delhi-1997.

**Reference Books:**

[R1] Degarmo E. Paul et.al, “Materials & Processes in Manufacture”, Prentice Hall India, New Delhi, 2001.

[R2] L. Krishna Reddi, “Principles of Engineering Metallurgy”, New Age Publication, New Delhi, 2001.

[R3] Buduisky et al, “Engineering Materials & Properties”, Prentice Hall India, New Delhi, 2004.

[R4] Peter Haasten, “Physical Metallurgy”, Cambridge Univ. Press, 1996.

[R5] Raymond A Higgin., “Engineering Metallurgy Part 1”, Prentice Hall India, New Delhi, 1998

**STRENGTH OF MATERIALS-I**

**Paper Code: ETME-211**  
**Paper: Strength of Materials-I**

L	T/P	C
3	1	4

**INSTRUCTION TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objectives: The students in this course are required to analyse reasons for failure of different components and select the required materials for different applications. For this purpose, it is essential to teach them concepts, principles, applications and practices covering stress, strain, bending moment, shearing force, shafts, columns and springs. Hence this subject has been introduced. It is expected that efforts will be made to provide appropriate learning experiences in the use of basic principles to the solution of applied problems to develop the required competencies.*

**UNIT – I**

**Simple Stresses & strains:** Concept of stress at a point, Tensile, Compressive, shear and volumetric stresses and Strains, Young's modulus, modulus of rigidity, complementary shear stress, lateral strain and Poisson's ratio. Strain relationships.

**Compound bars and Temperature stresses:** Stresses in compound bars carrying axial loads and subjected to temperature stresses.

**[T1, T2][No. of Hrs. 11]****UNIT – II**

**Simple bending:** Shear force and bending moment diagrams of cantilevers, simply supported beams under concentrated, uniformly loaded and varying loads with and without overhangs.

Stresses in beams and cantilevers under bending, beam of uniform strength, bending due to eccentric loads. Shear stress in beams, strain energy, Castigliano's theorem

Slope and deflection of cantilevers and beams under concentrated and uniformly distributed loads. Moment Area method, Macaulay's method; principle of superposition.

**[T1, T2][No. of Hrs. 11]****UNIT – III**

**Columns:** Combined direct and bending stresses in columns, Euler's and Rankine Gordon equations.

**Torsion:** Stresses and strains in pure torsion of solid circular shafts and hollow circular shafts. Power transmitted by shafts; combined bending and torsion. Strain energy in torsion

**Complex stresses and strains:** Principle stress and strain due to combination of stresses, Mohr's circle, strain energy, theories of Failures.

**[T1, T2][No. of Hrs. 11]****UNIT – IV**

**Springs:** Close-coiled springs, leaf springs.

**Cylinders:** Thin and thick cylinders, Lame's Theorem, compound cylinders, spherical vessels.

**[T1, T2][No. of Hrs. 11]****Text Books:**

[T1] Dr. Sadhu Singh "Strength of Materials", Khanna Pub.

[T2] Hibbler R.C., "Mechanics of Materials", Prentice Hall, New Delhi, 1994.

**Reference Books:**

[R1] Timoshenko S.P., Gere J "Elements of Strength of Materials", East-West affiliated, New Delhi,

[R2] Bhavikatti S. S. Strength of Materials", Vikas Publishers 2000

[R2] Sri Nath L.S. et.al., "Strength of Materials", McMillan, New Delhi, 2001

[R3] Popov Eger P., "Engg. Mechanics of solids", Prentice Hall, New Delhi, 1998

[R4] Fenner, Roger.T, "Mechanics of Solids", U.K. B.C. Publication, New Delhi, 1990



**NUMERICAL ANALYSIS & STATISTICAL TECHNIQUES LAB**

<b>Paper Code: ETMA-253</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Numerical Analysis &amp; Statistical Techniques Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**List of experiments:-**

1. Solution of algebraic and transcendental equation.
2. Algebra of matrices: Addition, multiplication, transpose etc.
3. Inverse of a system of linear equations using Gauss-Jordan method.
4. Numerical Integration.
5. Solution of ordinary differential equations using Runge-Kutta Method.
6. Solution of Initial value problem.
7. Calculation of eigen values and eigen vectors of a matrix.
8. Plotting of Unit step function and square wave function.

It is expected that atleast 12 experiments be performed, including the above specified 8 experiments which are compulsory. The remaining experiments may be developed by faculty and students based on applications of Mathematics in Real Life problem.

**Text Books:**

[T1] B.S. Grewal., “Numerical Methods in Engg. And Science”, Khanna Publications

[T2] P. Dechaumphai & N. Wansophark, “Numerical Methods in Engg.: Theories with Matlab, Fortran, C & Pascal Programs”, Narosa Publications

**Reference Books:**

[R1] P.B. Patil & U.P. Verma, “Numerical Computational Methods”, Narosa Publications

[R2] John C. Polking & David Arnold, “Ordinary Differential Equations using MATLAB”, Pearson Publications

[R3] Rudra Pratap, “Getting Started With MatLab” Oxford University Press

[R4] Byrom Gottfried, “Programming With C” Shaum’s Outline

[R5] Santosh Kumar, “Computer based Numerical & Statistical Techniques”, S. Chand Publications.

**ELECTRICAL MACHINE LAB****Paper Code: ETME-253****Paper : Electrical Machine Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:****Minimum 8 experiments are to be performed out of following list.**

- EXP: 1 To study the magnetization characteristics of a separately excited D.C generator for different speeds
- EXP: 2 To study the speed control of a d.c. shunt motor using  
 A. Field current control method  
 B. Armature control method
- EXP: 3 To plot torque-speed characteristics and armature current characteristics of a D.C shunt motor.
- EXP: 4 To determine the external or load characteristics of a D.C. shunt generator by actually loading the machine.
- EXP: 5 To study 3-point/ 4-point starter for D.C. shunt motor.
- EXP: 6  
 A. To perform no load and short circuit test on a three-phase synchronous generator.  
 B. Measure the resistance of the stator windings  
 C. Find the voltage regulation at full load at (i) Unity power factor (ii) 0.85 power factor leading (iii) 0.85 power factor lagging by synchronous impedance method.
- EXP: 7 To study the effect of variation of field current upon the stator current and power factor of a synchronous motor running at no load and half load, hence draw V and inverted V curves of the motor.
- EXP: 8 To Perform no load and blocked rotor test on three-phase induction motor and draw its equivalent circuit.
- EXP: 9 To perform load test on 3-phase induction motor and compute torque, output power, efficiency, input power factor and slip for various load settings. Plot the relevant graphs.
- EXP: 10 Perform no load and blocked rotor test on single-phase induction motor.

**Reference Books:**

- R1. Laboratory Operations for Rotating Electric Machinery and Transformer Technology, Donald V. Richardson, Prentice Hall, 1980
- R2. Electric Machinery Experiments: Laboratory Practices and Simulation Studies, Sailendra Nath Bhadra, Alpha Science International Ltd, 2013

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

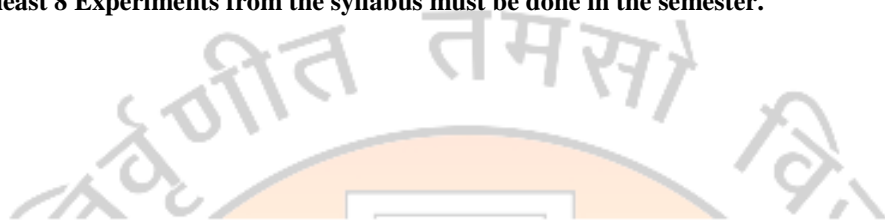
**PRODUCTION TECHNOLOGY LAB**

**Paper Code: ETME-255**  
**Paper: Production Technology Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**Production Technology Lab experiments based on syllabus (ETME-205).**

**NOTE:- At least 8 Experiments from the syllabus must be done in the semester.**



**STRENGTH OF MATERIAL-I LAB****Paper Code: ETME-257****Paper: Strength of Material-I Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. To perform tensile test in ductile and brittle materials and to draw stress-strain curve and to evaluate various mechanical properties.
2. To perform compression test on C.I. and to determine ultimate compressive strength.
3. To perform shear test on different materials and determine ultimate shear strength.
4. To perform hardness test (Rockwell, Brinell & Vicker's test) on different materials (aluminium, steel, C.I, wood, Alloy Steel)
5. To perform impact test to determine impact strength.
6. To perform torsion test and to determine various mechanical properties.
7. Open Coil spring test.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**MACHINE DRAWING LAB**

**Paper Code: ETTE-259**

**Paper: Machine Drawing Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>3</b>	<b>2</b>

**List of Experiments:**

**UNIT – I**

**Theory of Dimensioning & BIS Convention:** Element of Dimensioning, Chain Dimensioning, Parallel Dimensioning, Coordinate Dimensioning, Dimensioning of the Common Features such as Diameter, Radii, Arcs, Angles, chamfers, etc. Conventional representation of Threads and threads parts, springs, Gears, Welded and riveted joints, Threaded fasteners, Sectional views and sectioning convention and other common features.

[T1,T2][No. of Hrs. 10]

**Unit – II**

**Theory of Tolerances & Surface Characteristics:** Some basic definition, Tolerances including the grade and application, different types of tolerance, Fundamental Deviation, Fits and its types, basis and selection. Basic terminology of GD&T, Tolerance characteristics and symbols Surface texture symbols & Surface lay indication.

[T1,T2][No. of Hrs. 10]

**Unit - III**

**Different Fastening Arrangement and Joints:** various threads profiles bolt variety of foundation Bolts such as Hoop Bolt, Lewis Bolt, Rag Bolt, Keyed Joints, Cotter Joints, Knuckle Joints, Rigid coupling and flexible coupling.

[T1,T2][No. of Hrs. 10]

**Unit-IV**

Assembly drawing of plumber block, Tool Post, tool holder, Tail stock, etc. Tool head and clapper box of shaper, Hand drill.

A significant part of the drawing work should be done using CAD package (e.g., Autodesk, Solid Work, Pro-E etc)

[T1,T2][No. of Hrs. 13]

**Text Books:**

[T1] Textbook of Machine Drawing by Er R.K. Dhawan S.Chand Publications

[T2] Machine Drawing by Basudeb Bhattacharyya OXFORD University Press

**Reference Books:**

[R1] Machine Drawing by N.Sideshwer, P. Kannaiaha, V.V.S. Sastry, Tata McGraw Hill Education

[R2] Machine drawing by N.D.Bhatt (Charotar Publications).

[R3] Machine drawing by P.S.Gill (S.K. Kataria & Sons)

## KINEMATICS OF MACHINES

**Paper Code: ETME-202**  
**Paper: Kinematics of Machines**

L	T/P	C
3	1	4

### **INSTRUCTION TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objectives of this course are to cover the mathematical skills to enable high-fidelity kinematics analysis of machine elements including linkages, Friction, cams, and gears, within the general machine design context.*

### **UNIT – I**

**General concepts, Velocity and Acceleration Analysis:** Introduction of Simple mechanism, Different types of Kinematics pair, Grublers rule for degree of freedom, Grashof's Criterion for mobility, inversions of four bar chain, slider crank chain and double slider crank chain, Velocity of point in mechanism, relative velocity method, Velocities in four bar mechanism, slider crank mechanism and quick return motion mechanism, Instantaneous center method, Types & location of instantaneous centers, Kennedy's theorem, Velocities in four bar mechanism & slider crank mechanism Acceleration of a point on a link, Acceleration diagram, Coriolis component of acceleration, Crank and slotted lever mechanism, Klein's construction for Slider Crank mechanism and Four Bar mechanism, Analytical method for slider crank mechanism.

[T1,T2] [No. of Hrs. 12]

### **UNIT-II**

**Mechanism with lower pairs:** Description of Straight line mechanisms like Peaucellier's mechanism and Hart mechanism, Engine indicator mechanism, Steering mechanism of vehicles, Hook's joints.

**Cams:** Classification, Cams with uniform acceleration and retardation, SHM, Cycloidal motion, oscillating followers.

[T1,T2] [No. of Hrs. 10]

### **UNIT – III**

**Friction:** Concepts of frictions and wear related to bearing and clutches, Belt and pulley drive, Length of open and cross belt drive, Ratio of driving tensions for flat belt drive, centrifugal tension, condition for maximum power transmission, V belt drive

**Brakes & Dynamometers:** Shoe brake, Band brake, Band and Block brake, Absorption and transmission type dynamometers.

[T1] [No. of Hrs. 10]

### **UNIT IV**

**Gears:** Simple gear train, Compound gear train, Reverted gear train, trains – Analysis by tabular and relative velocity method, fixing torque, Sun and planet gear, Geometry of tooth profiles, Law of gearing, involute profile, Path of contact. Arc of contact, Contact ratio, Interference in involute gears. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth. Profile Modification., helical, spiral and worm gears.

[T1,T2] [No. of Hrs. 12]

### **Text Books**

[T1] Theory and Machines: S.S. Rattan, Tata McGraw Hill.

[T2] Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Second Edition, MGH, New York

### **Reference Books**

[R1] Thomas Beven, "The Theory of Machines", CBS Publishers,

[R2] V.P. Singh, "Theory of Machines", Dhanpat Rai & Co.(P)Ltd

[R3] Malhotra & Gupta, "The Theory of Machine", Satya Prakashan,.

[R4] Ghosh A & Malik A K " Theory of Mechanisms and Machines" Affiliated East West Press

**STRENGTH OF MATERIALS-II****Paper Code: ETME-204****Paper: Strength of Materials-II**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTION TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To provide basic knowledge in mechanics of materials so that the students can solve real engineering problems and design engineering systems. In this way, the student will be able to pre-design different types of elements, for mechanical components*

**UNIT I**

**3D Stress:** Three dimensional stress and strain, Stress tensor, stress invariants, Strain Tensor, Equilibrium Equations, St. Vernants principle, generalized hooks law, Theories of elastic failure.

**Strain Energy:**

Strain Energy Due to Axial Force, Shear Stress, Bending; Maxwell's reciprocal theorem, Castigliano's theorem for statistically determinate structures.

**[T1,T2][No. of Hrs. 11]****UNIT II**

**Shear Stresses in Beams:** Shear stress at a section, shear stress distribution for different sections: square, rectangular, Triangular, Circular section, I-section, T-section.

**Thick Cylinders:** Stresses in thick cylinders, sphere subjected to internal pressure, Lamé's equations, compound cylinders, spherical vessels, hub shrunk on solid shafts.

**[T1][No. of Hrs. 11]****UNIT-III**

**Columns:** Combined direct and bending stresses in columns, Euler's and Rankine Gordon equations, applications of Johnson's empirical formula for axially loaded columns.

**Curved Beams:** Bending of beams with large initial curvature, position of neutral axis for rectangular, trapezoidal and circular cross sections, stress in crane hooks.

**[T1,T2][No. of Hrs. 11]****UNIT IV**

**Rotating Disc and Cylinders:** Rotational stresses in discs and rims of uniform thickness; discs of uniform Strength, long cylinder.

**Unsymmetrical Bending and Shear Centre:** Properties of beam cross-section, Principal Axes, Determination of Principal Axes, stress and deflection in unsymmetrical bending, shear centre.

**[T2] [No. of Hrs. 11]****Text Books:**

- [T1] Dr. Sadhu Singh, "Strength of Materials", Khanna Publishers  
 [T2] Hibbler R.C., "Mechanics of Materials", Prentice Hall, New Delhi, 1994.

**Reference Books:**

- [R1] U. C. Jindal "Strength of Materials" Pearson Education India  
 [R2] Beer, Johnston "Mechanics of Materials" fifth edition McGraw-Hill,  
 [R3] Debabrata Nag & Abhijit Chanda "Strength of Materials", 2<sup>nd</sup> edition, John Wiley & Sons publisher  
 [R4] Sri Nath L.S. et.al., "Strength of Materials", McMillan, New Delhi, 2001  
 [R5] Timoshenko S.P., Gere J "Elements of Strength of Materials", East-West affiliated, New Delhi, 2000  
 [R6] Popov Eger P., "Engg. Mechanics of solids", Prentice Hall, New Delhi, 1998  
 [R7] Fenner, Roger.T, "Mechanics of Solids", U.K. B.C. Publication, New Delhi, 1990

**MANUFACTURING MACHINES**

**Paper Code: ETME-206**  
**Paper: Manufacturing Machines**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: The objective of the paper is to facilitate the student with manufacturing processes using machine tools in use today and it's application in different type of Industries.*

**UNIT - I**

**Introduction:** Classification of machine tools based on application and production rate: General purpose and Special purpose machines, Classification based on-types of machine tools and the processes, Generating and forming.

**Elements of metal cutting processes:** Elements of tool geometry, cutting tool materials and applications.

**Lathe:** Various types of lathe: Centre lathe, facing lathe, gap-bed lathe, capstan and turret lathe, NC, CNC and DNC lathe, major difference between CNC lathe and conventional lathe. Major sub-assemblies of a lathe: Bed, headstock, tail stock, carriage consisting of saddle, cross-slide, compound slide, tool post and apron. Work holding devices: self centering three jaw chuck, independent four jaw chuck, collets, face plates, dog carriers, centers and mandrels, Rest(Steady and Moving).

[T1,T2][No. of Hrs: 11]

**UNIT - II**

**Lathe Contd.:** Driving mechanisms, apron mechanism, thread cutting mechanism and calculations, features of half-nut engagement – disengagement, indexing dial mechanism. Operations on lathe: taper turning, related calculations, thread cutting, facing, under-cutting, drilling, boring, parting-off, knurling, chamfering.

**Reciprocating Type Machine Tools:** Shaper, Planer and Slotter: Constructional features, basic machines and kinematics and related calculations.

[T1][No. of Hrs: 10]

**UNIT III:**

**Drilling Machines:** Constructional features of bench drilling machine, radial drilling machine, multi-spindle drilling machine, feed mechanism, work holding devices, Tool – holding devices. Different drilling operations: Drilling, reaming, counter boring and countersinking etc. estimation of drilling time.

**Milling Machines:** Types of general purpose milling machines: horizontal, vertical, universal and their principal parts. Types of milling cutters and their applications, different milling operations, work-holding devices: vice, clamps, chucks, dividing head and its use, simple, compound and differential indexing. Indexing calculations and machining time calculations. Introduction to machining centers.

[T1,T2][No. of Hrs: 11]

**UNIT IV:**

**Grinding Machines:** Different types of grinding machines: cylindrical, surface and centre-less grinding machines, basic constructional features and mechanisms, specifications, different grinding operations, honing, lapping and super-finishing processes.

**Gear Manufacturing Machines:** Gear forming, gear generation, gear shaping and gear hobbing.

[T1][No. of Hrs: 10]

**Text Books:**

- [T1] B.S. Raghuwanshi, “Workshop Technology”, Vol.2, Dhanpat Rai & Sons, 2003.  
 [T2] S.F. Krar Stevan F. and Check A.F., “Technology of M/C Tools”, McGraw Hill Book Co., 1986  
 [T3] Hazra Chandhari S.K., “Elements of Workshop Technology”, Vol.2, Media Promoters, 2003.

**Reference Books:**

- [R1] P.C. Sharma, “A Text Book of Production Engineering”, S. Chand, New Delhi, 2004.  
 [R2] Bawa H.S., “Workshop Technology”, Vol.2, Tata McGraw Hill, 2004.  
 [R3] Juneja & Shekhon, “Fundamental of Metal Cutting”, New Age Publications  
 [R4] Kibbe Richard et al, “M/c Tool practices”, Prentice Hall India, 2003.  
 [R5] Gerling Heinrich, “All about Machine Tools”, New Age Publication, 2003



**MEASUREMENTS AND INSTRUMENTATION****Paper Code: ETME-208****Paper: Measurements and Instrumentation**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective:-To provide the basic understanding about operational characteristics and applications of various sensors and transducers.*

**UNIT I****Introduction of Measurement:**

Block diagram and components of measuring instrumentation system, classifications of instruments, static and dynamic characteristic of instruments. Errors in measurements: gross errors, systematic errors. Calibration of instruments: process of calibration, standard of calibration and classification of standard.

**Different Sensors:**

Introduction sensing element used in temperature, pressure, force, torque and flow measurement. Transducers: Introduction and classification.

**[T1][No of Hrs.12]****UNIT-II**

**Transducers:** Constructional features, working principle and applications of resistive, Inductive, Capacitive, Photoelectric, magnetostrictive, Ionization, piezoelectric, halleffect, Thermoelectric and digital transducers.

**[T1][T2][No of Hrs.10]****UNIT-III**

**Measurement of Pressure:** Classification of pressure measuring devices, high pressure and low pressure measurement, Vacuum pressure measurement.

**Measurement of Flow:** Method of flow measurement, obstruction meters, electromagnetic flow meters, hot wire anemometer, ultrasonic flow meter.

**[T1][T2][No of Hrs.10]****UNIT-IV**

**Measurement of Temperature:** Thermometer, thermocouples, thermistors, resistance thermometers and pyrometers.

**Strain Gauges and Related Measurement:** Electric resistance strain gauge, semiconductor strain gauge, temperature problems and compensation, applications of strain gauges in measurement, Measurement of Force, Displacement, Rotating speed, torque, Level, Humidity and Moisture.

**[T1][T2][No of Hrs.10]****Text Books:**

[T1] D. V. S. Murty, "Transducers and Instrumentation", PHI Learning Pvt. Ltd

[T2] A. K. Shawney, "Electrical & Electronic Measurement & Instruments", Dhanpat Rai & Sons Publications, 2000

**Reference Book:**

[R1] E.O.Doebelin, Dhanesh N Manik, "Measurement Systems", 6<sup>th</sup> Edition, McGraw Hill Education.

[R2] John P. Bentley, "Principles of Measurement System", 4<sup>th</sup> Edition, Pearson Prentice Hall

[R3] D. Patranabis, "Sensors and Transducers", PHI Learning Pvt. Ltd., 2nd edition

**IC ENGINES & GAS TURBINES****Paper Code: ETME-210****Paper: IC Engines & Gas Turbines**

L	T/P	C
3	1	4

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS : 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: To introduce the students about basic knowledge of components and working principles of different types of engines and turbines.*

**UNIT- I:**

**Introduction:** Basic Engine components and Nomenclature, Classification of Engines, The working principle of Engines, Comparison of 2-Stroke and 4-Stroke Engines; CI, and SI Engines, Ideal and Actual Working Cycles and their analysis, Valve timing Diagram.

**Fuels:** Fossil fuels, Chemical structure of Petroleum, Properties of SI and CI Engine Fuels, Fuel Ratings; Octane Number, Cetane Number.

**[T1, R1, R2] [No. of Hrs. 11]****UNIT- II:**

**Carburetors & Fuel Injection:** Air Fuel Mixture Requirements, Construction and Working of Simple Carburetor, Calculation of Air-Fuel Ratio, Parts of Carburetor.

Requirement of Injection Systems, Classification of Injection Systems, Fuel Feed pump, Injection Pumps, Working principles of Governors, Nozzles and Fuel Injector, Injection in SI and CI Engines.

**Combustion and Ignition Systems in SI and CI Engines:** Normal and Abnormal Combustion in SI and CI Engines, Stages of Combustion, Detonation and Knocking.

**[T1, R1, R2] [No. of Hrs. 11]****UNIT- III:**

**Performance parameters for IC Engines:** Engine Power, Engine Efficiencies, Performance Characteristics, Variables Effecting Performance Characteristics, Methods of Improving Engine Performance, Heat Balance.

**Modern Automotive Engines:** Changes in Fuel injection Methods in S.I and C.I engines, Common Rail Direct Injection System, Gasoline Direct Injection, Variable Valve Technology, A brief review of Design changes to achieve high efficiency.

**[T1, T2, R1, R2, R3, R4][No. of Hrs. 11]****UNIT- IV:**

**Gas Turbine:** Introduction to Gas Turbines, Development, Classification and Application of Gas Turbines, Ideal and Actual Cycles; Effect of Intercooling, Reheating, Regeneration, Combined cycle and Cogeneration.

**Gas Turbine Cycles for Aircraft Propulsion:** Criteria of performance, Intake and propelling nozzle efficiencies, Simple Turbojet Cycle, The turboprop engine, Thrust augmentation, Gas turbine combustion systems, Combustion chamber designs, Gas Turbine Emissions.

**[T2, R3, R4] [No. of Hrs. 11]****Text Books:**

[T1] Ganesan V., "Internal Combustion Engines", Tata McGraw-Hill

[T2] H.H Saravanamutto, H. Cohen, GFC Rogers "Gas Turbine Theory", Pearson.

**Reference Books:**

[R1] John B Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill.

[R2] K.K. Ramalingam, "Internal Combustion Engines" 2nd ed, SCITECH Publications.

[R3] E.T. Vincent "Theory & Design of Gas Turbine and Jet Engine" Tata McGraw Hill.

[R4] Gas Turbine Principles and Practice, Cox Newnes.

**FLUID MECHANICS****Paper Code: ETME-212****Paper: Fluid Mechanics**

L	T/P	C
3	1	4

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objectives: The objective of this subject to provide an understanding of the fundamentals of fluid mechanics, an appreciation of the design principles in fluid systems, the ability to analyse existing fluid systems and contribute to new designs.*

**UNIT- I**

**Fundamental Concepts of Fluid Flow:** Fundamental definitions, Fluid properties, classification of fluids, Flow characteristics, Foundations of flow analysis, Incompressible and compressible fluids, one, two and three dimensional flows,

**Pressure and its measurements:** Pascal's law, pressure variation in a fluid at rest, Classification of different manometers.

**Fluid Statics:** Fluid pressure, Forces on solid surfaces, Buoyant forces, Metacentre and Metacentric height. Stability of floating bodies,

**[T1, T2, R1, R2, R3][No. of Hrs. 11]****UNIT- II**

**Kinematics of Fluid Flow:** Types of fluid flow, streamline, path line and streak line; continuity equation, Equations for acceleration, Irrotational and rotational flow, velocity potential and stream function, Vortex flow, Continuity equation.

**Dynamics of Fluid Flow:** Control volume analysis, Eulers equation of motion, Bernoulli's equation, Bernoulli's theorems from steady flow energy equation, Venturi meter; Pitot tube, Momentum equation.

**Laminar Flow:** Reynold's experiment, Critical velocity, Steady laminar flow through a circular tube, Measurement of viscosity.

**[T1, T2, R1, R2, R3] [No. of Hrs. 11]****UNIT- III**

**Turbulent Flow:** Shear stress in turbulent flow. Hydro dynamically smooth & rough boundaries. Velocity distribution for turbulent flow in smooth and rough pipes.

**Boundary Layer Flow:** Boundary Layer Theory and Applications: Boundary Layer thickness, displacement, momentum and energy thickness, Flow separation, Drag and lift on immersed bodies.

**Pipe Flow Systems:** Darcy-Weisbach equation, Moody diagram, Energy losses in pipelines, concept of equivalent length, Flow between two reservoirs multiple pipe systems. Siphon.

**[T1, T2, R1, R2, R3][No. of Hrs. 11]****UNIT- IV**

**Dimensional Analysis and Principles of Similarity:** Buckingham's Theorem and its applications, Geometric, Kinematics and Dynamic similarity; Dimensionless numbers-Reynolds, Froude, Euler, Mach, Weber Number and their significance.

**Flow Measurements:** Measurement of flow using, orifice meter, nozzle, Measurement of flow in open channels – rectangular, triangular, trapezoidal weir, Cipoletti weir. Hot-wire anemometer.

**[T1, T2, R1, R2, R3] [No. of Hrs. 11]****Text Books:**

[T1] R.K. Basal, "Fluid Mechanics & Hydraulic Machines", Laxmi Publications(P) Ltd.,2002.

[T2] D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering", S.K. Kataria & Sons,2000.

**Reference Books:**

[R1] I.H. Shames, "Mechanics of Fluids", Tata McGraw Hill

[R2] V.L. Streeter and E.B. Wylie, "Fluid Mechanics", Tata McGraw Hill

[R3] Modi, P.N., and Seth, S.H., "Hydraulics and Fluid Machines", Standard Book House,

[R4] Vijay Gupta and S.K.Gupta, "Fluid Mechanics and its Applications", Wiley Eastern Ltd,

[R5] Som, S.K. & Biswas G. : Introduction of fluid mechanics & Fluid Machines, TMH, 2000,

**KINEMATICS OF MACHINES LAB****Paper Code: ETME-202****Paper: Kinematics of Machines Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Study of various links and mechanisms.
2. Study and draw various inversions of 4- bar chain and single slider crank chain.
3. Draw velocity and diagram of engine mechanism using graphical methods including Klien's construction.
4. CAM Analysis - angle Vs displacement and jump phenomenon.
5. To generate spur gear involute tooth profile using simulated gear shaping process
6. Determination of gear- train value of compound gear trains and Epicyclic gear trains.
7. To study various types of gears – Helical , cross helical worm, bevel gear.
8. Determination of moment of inertia of systems.
9. Create various types of linkage mechanism in CAD and simulate for motion outputs and study the relevant effects.

**NOTE:- At least 8 Experiments from the list must be done in the semester.**

**STRENGTH OF MATERIALS-II LAB****Paper Code: ETME-254****Paper: Strength of Materials-II Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Study of performance of Fatigue & Creep tests
2. To perform bending test on beam (wooden or any other material) and to determine the Young's modulus and Modulus of rupture
3. To find the Shear Modulus of Elasticity of two different materials; Aluminum and Steel using two twist and bent test rigs are used.
4. To determine the Modulus of Elasticity and Poison's ratio of Aluminum, the specimen being a cantilever beam, and compare them with theoretical value
5. To determine principal stresses and strains in a beam made of aluminum and loaded as a cantilever, and compare them with theoretical values
6. Flexural test on beam (central point load)
7. Flexural test on beam (two point load)
8. Determination of Bucking loads of long columns with different end conditions.

**NOTE:- At least 8 Experiments from the list must be done in the semester.**

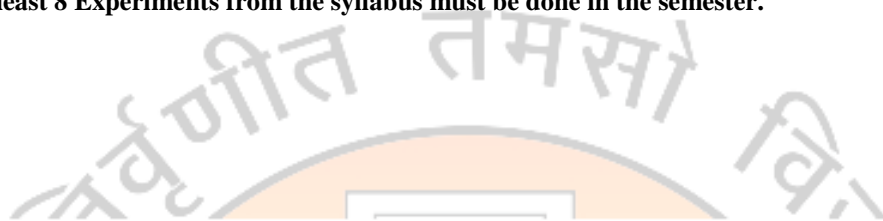
**MANUFACTURING MACHINES LAB**

**Paper Code: ETME-256**  
**Paper: Manufacturing Machines Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**Manufacturing Machines Lab experiments based on syllabus (ETME-206).**

**NOTE:- At least 8 Experiments from the syllabus must be done in the semester.**



**I.C. ENGINES AND GAS TURBINES LAB**

<b>Paper Code: ETME-258</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: I.C. Engines and Gas Turbines Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. To draw the Valve Timing Diagram using the Cut Section CI Engine Model.
2. To draw the Valve Timing Diagram using the Cut Section SI Engine Model.
3. To make a trial on single cylinder 4-stroke Diesel Engine to calculate B.H.P., S.F.C. and to draw its characteristics curves.
4. To make a trial on 4-stroke high-speed diesel engine and to draw its Heat Balance Sheet.
5. To make a trial on SI Engine at constant speed to calculate B.H.P., S.F.C., Thermal efficiency and to draw its characteristic Curves.
6. To make Morse Test to calculate IHP of the multi cylinder petrol engine and to determine its mechanical efficiency.
7. To Study Lubrication and cooling systems employed in various I. C. Engines in the Lab.
8. To Study Braking system of automobile in the lab.
9. To study a Carburetor.
10. To study (I) the Fuel Injection System of a C.I. Engine.  
(II) Battery Ignition system of a S.I. Engine.
11. To study multi Cylinder four strokes vertical Diesel Engine test RIG with Hydraulic Dynamometer.
12. To study the Gas Turbine Model.

**NOTE:- At least 8 Experiments from the list must be done in the semester.**

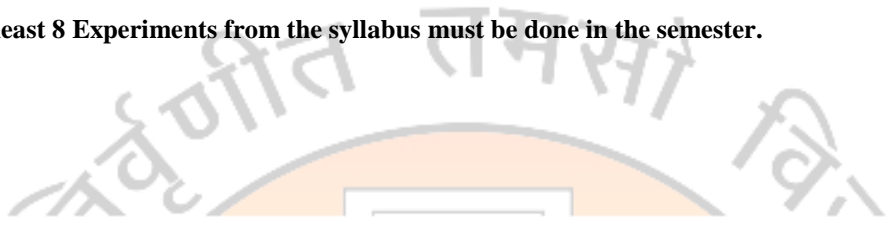
**FLUID MECHANICS LAB**

**Paper Code: ETME-260**  
**Paper: Fluid Mechanics Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**Fluid Mechanics Lab experiments based on syllabus (ETME-201).**

**NOTE:- At least 8 Experiments from the syllabus must be done in the semester.**





**MANAGEMENT OF MANUFACTURING SYSTEMS**

**Paper Code: ETME-301**

**L T/P C**

**Paper: Management of Manufacturing systems**

**3 0 3**

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: The objective of the paper is to facilitate the student with problems and solutions in managing factory operations.*

**UNIT I:**

**Introduction:** Production functions, Management systems, production and productivity.

**Plant Organization:** Principles of organization, Organization structure-line and staff organization.

**Plant Location, Layout:** Process layout, product layout and combination – methods of layout, economics of layout; group technology.

[T1,T2][No. of Hrs. 11]

**UNIT II:**

**Production Planning & Control:** Types of products, demand, demand forecasting, marketing strategies, scheduling and control of scheduling production control.

**Method Study:** Definition and concepts, method study procedures, symbols, advantages, Operation process chart, Flow process charts, Two hand process chart, Motion study, micro motion, SIMO charts, Systems Concepts, Classification analysis techniques, Principle of motion economics.

**Work Measurement:** Definition, objectives & techniques, Time study equipment, performance rating, allowances, standard time, work sampling, PMTS.

[T1,T2][No. of Hrs. 11]

**UNIT III:**

**Industrial Maintenance:** Types, organization for maintenance department, Breakdown and preventive maintenance and corrective maintenance.

**Inventory control and replacement analysis:** Introduction replacement policy and method adopted, EOQ.

[T1,T2][No. of Hrs. 11]

**UNIT IV:**

**Management Concepts:** Development of management principles, scientific management, human relation aspects.

**Production Cost Concepts:** Introduction, cost of production, cost centre and unit, Classification and analysis of cost, break Even Analysis.

[T1,T2][No. of Hrs. 11]

**Text Books:**

[T1] Ravi Shankar, “Industrial Engg. & Management”, Galgotia Publications

[T2] S.K. Sharma, “Industrial Engg. & Operation Management”, S.K. Kataria & Sons.

**Reference Book:**

[R1] Joseph S. Martinich, “Production & Operation Management”, John Wiley & Sons.

[R2] S. N. Chary, ” Production and operations management, TMH 4<sup>th</sup> edition

[R3] Harold T. Amrine, John A. Ritchey, Colin L. Moodie, Joseph F. Kmec “Manufacturing organization and Management” Pearson publication 6<sup>th</sup> edition

[R4] S. Anil Kumar, N. Suresh “Production and operations management”, New age International, 2<sup>nd</sup> Ed.

[R5] M. Mahajan, “Industrial Engg. & Production Management”, Dhanpat Rai & Co.

**HEAT TRANSFER****Paper Code: ETME-303****Paper: Heat Transfer**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: The objective of this paper is to introduce the student about the concepts of Heat Transfer.*

**UNIT – I****Basic Concepts:** Mechanism of Heat Transfer, Conduction, Convection and Radiation.

**Conduction:** Fourier Law of Conduction, Thermal Resistance and its electrical Analogy, General Differential equation of Heat Conduction in Cartesian and Cylindrical Coordinates, One Dimensional Steady State Heat Conduction with and without heat generation through Plane Wall, Cylinders and Spherical systems. Composite Systems, Extended Surfaces, Methods for solving two-dimensional steady state conduction problems. Unsteady Heat Conduction, Lumped Analysis, Use of Heislers Chart. Critical Thickness of Insulation.

**[T1, T2, T3][No. of Hrs. 11]****UNIT - II****Convection:** Basic Concepts, Heat Transfer Coefficients, Boundary Layer Concept, Types of Convection

**Forced Convection:** Dimensional Analysis, External Flow, Flow over Plates, Cylinders and Spheres. Internal Flow, Laminar and Turbulent Flow, Combined Laminar and Turbulent, Flow over Bank of tubes.

**Free Convection:** Dimensional Analysis, Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres.

**[T1, T2, T3][No. of Hrs.11]****UNIT – III**

**Condensation and Boiling:** Film-wise condensation on vertical plate and horizontal tubes. Condensation inside tubes, Regimes of Pool boiling. Calculations on Nucleate boiling, Critical Heat flux and Film boiling, correlations in boiling and condensation.

Types of Heat Exchangers, Heat Exchanger Analysis, LMTD Method and NTU-Effectiveness method. Overall Heat Transfer Coefficient, Fouling Factors.

**[T1, T2, T3][No. of Hrs. 11]****UNIT – IV**

**Radiation:** Basic Concepts, Laws of Radiation, Stefan Boltzman Law, Kirchoffs Law, Black Body Radiation, Grey body radiation, Radiation exchange between surfaces, Shape Factor Algebra, Hottel's method for estimating shape factor, Electrical Analogy, Radiation Shields, Radiation from gases and vapours, Solar Radiation, Effect of radiation on temperature measurement.

**[T1, T2, T3][No. of Hrs. 11]****Text Books:**

- [T1] R. C. Sachdeva "Heat Transfers" McGraw Hill.  
 [T2] Incropera, Dewitt, "Fundamentals of Heat and Mass Transfer".  
 [T3] P. K. Nag "Heat and Mass Transfer" McGraw Hill.

**Reference:**

- [R1] Holman, J.P., "Heat Transfer", Tata McGraw Hill Book Company.  
 [R2] Kothandaraman C.P., "Fundamentals of Heat and Mass Transfer", New Age International Publisher.  
 [R3] Domkundwar S., Arora S.C., Domkundwar AnandV., "A course in Heat and Mass Transfer", Dhanpat Rai & Company.  
 [R4] Rathore Mahesh M., "Engineering Heat and Mass Transfer", University Science Press.  
 [R5] Ozisik M.N, "Heat Transfer", McGraw-Hill Book Co.

**DYNAMICS OF MACHINES**

**Paper Code: ETME-305**  
**Paper: Dynamics of Machines**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: The objectives of the subject is to provide the tools necessary for dynamic analysis of mechanisms and machines, and the skills necessary to consider the role of dynamics in the design of machines.*

**UNIT I**

**Force Analysis and Flywheel:** Static equilibrium, Static, superposition, Static force analysis of simple mechanisms, Inertia force and Inertia torque, D'Alembert's principle, Dynamic force analysis of four link mechanism and slider crank mechanism, Engine force analysis-Piston and crank effort, Gas forces, Equivalent dynamical systems, inertia of connecting rod, inertia force in reciprocating engines (graphical method), Turning moment diagrams, Fluctuation of energy, Fly Wheel, Punch press.

**[T1, T2][No. of Hrs. 11]****UNIT II**

**Balancing:** Balancing of rotating parts and primary balancing of reciprocating parts, primary and secondary balancing of in-line engines, Balancing of Radial Engines, partial balancing of locomotive engines and its effect, balancing machines, Field Balancing.

**[T1, T2][No. of Hrs. 11]****UNIT III****Mechanisms for Control:**

**Governors:** Types of Governor, Watt Governor, Porter governor, Proell Governor, Hartnell Governor, Wilson-Hartnell governor, Sensitiveness of a Governor, Stability, Isochronism, Hunting, Governor Effort and Power, controlling force.

**Gyroscope:** Gyroscopic effect and Gyroscope: gyroscopes, Gyroscopic Torque, gyroscopic stabilization, Gyroscopic Effects on Aeroplanes, and ship, stability of an automobile.

**[T1][No. of Hrs. 11]****UNIT IV**

**Free Vibration:** Basic features of vibratory systems, Degrees of freedom, single degree of freedom, Free vibration, Equations of motion, Natural frequency, Types of Damping, Damped vibration, Extending to multi degree freedom systems, Critical speeds of shafts, Torsional vibration..

**Forced Vibration:**

Harmonic disturbances, Disturbance caused by unbalance, Support motion, force transmissibility and amplitude transmissibility, Vibration isolation.

**[T1][No. of Hrs. 11]****Text Books:**

[T1] Theory and Machines: S.S. Rattan, Tata McGraw Hill.

[T2] Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Second Edition, MGH, New York

**Reference Books:**

[R1] Thomas Beven, "The Theory of Machines", CBS Publishers,

[R2] V.P. Singh, "Theory of Machines", Dhanpat Rai & Co.(P)Ltd

[R3] Malhotra & Gupta, "The Theory of Machine", Satya Prakashan

[R4] Ghosh A & Malik A K "Theory of Mechanisms and Machines" Affiliated East West Press.

[R5] J.S Rao, "Mechanical Vibration", New age publication.

**MACHINE DESIGN -I**

**Paper Code: ETME–307**  
**Paper: Machine Design-I**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objectives: The primary objective of this course is to demonstrate how engineering design uses the many principles learned in previous engineering science courses and to show how these principles are practically applied. The emphasis in this course is on machine design: the design and creation of devices that consist of interrelated components used to modify force and/or motion.*

**UNIT –I**

**Introduction:** Principles of mechanical design, systematic design process, aesthetic and ergonomic considerations in design, use of standards in design.

Manufacturing consideration in design: casting, machining, forging

Dynamic and fluctuating stresses, fatigue failure and endurance limit, stress concentration, causes and remedies in design, Factor of safety, Failure theories, Tolerances and types of fits as per BIS, Selection of materials, designation of steels.

[T1, T2][No. of Hrs. 11]

**UNIT - II**

**Design of Elements:** Cotter and knuckle joints; screwed fastenings, bolted and riveted joints under direct and eccentric loads, initial tightening loads in bolts.

Welded joints, strength of welded joints, eccentrically loaded joints, welded joints subjected to bending moment and torsion.

[T1, T2][No. of Hrs. 11]

**UNIT - III**

Shafts, keys and couplings –design of rigid and pin bushed flexible couplings.

Levers design

Pipes, cylinder and design of pipe joints

Springs, uses and design of close coiled helical springs shot peening of springs.

[T1, T2][No. of Hrs. 11]

**UNIT - IV**

Design of various types of power screws, : screw jack, C- clamp, toggle screw jack.

Classification of Gears, spur gears, Lewis equation, subjected to dynamic and wear loads, gear failures.

[T1, T2][No. of Hrs. 11]

**Text Books:**

[T1] Maleeve Hartman and O.P.Grover, “Machine Design”, CBS Publication & Publishers

[T2] V.B. Bhandari, “Machine Design”, Tata McGraw Hill

**Reference Book:**

[R1] Mahadevan, “Design Data Book”, CBS Publishers & Distributors

[R2] J.E. Shigley & C.R. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Co. Inc.

[R3] P.C. Sharma and D.K Aggarwal., “Machine Design”, S.K. Kataria & Sons

[R4] Juvinal R C, Marshek K M, “Fundamentals of Machine component Design”, Wiley India

[R5] Norton R. I. “Machine Design” Pearson

**CONTROL SYSTEMS**

**Paper Code: ETEL-307**

**Paper: Control Systems**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To teach the fundamental concepts of Control systems and mathematical modeling of the system. To study the concept of time response and frequency response of the system. To teach the basics of stability analysis of the system*

**UNIT I : Control Systems - - Basics & Components**

Introduction to basic terms, classifications & types of Control Systems, block diagrams & signal flow graphs. Transfer function, determination of transfer function using block diagram reduction techniques and Mason's Gain formula. Control system components: Electrical/ Mechanical/Electronic/A.C./D.C. Servo Motors, Stepper Motors, Tacho Generators, Synchros, Magnetic Amplifiers, Servo Amplifiers,

[T1,T2][No. of Hrs. : 11]

**UNIT II : Time – Domain Analysis**

Time domain performance specifications, transient response of first & second order systems, steady state errors and static error constants in unity feedback control systems, response with P, PI and PID controllers, limitations of time domain analysis.

[T1,T2][No. of Hrs. : 10]

**UNIT III : Frequency Domain Analysis**

Polar and inverse polar plots, frequency domain specifications and performance of LTI systems, Logarithmic plots (Bode plots), gain and phase margins, relative stability. Correlation with time domain performance closes loop frequency responses from open loop response. Limitations of frequency domain analysis, minimum/non-minimum phase systems.

[T1,T2][No. of Hrs. : 10]

**UNIT IV : Stability & Compensation Techniques**

Concepts, absolute, asymptotic, conditional and marginal stability, Routh–Hurwitz and Nyquist stability criterion, Root locus technique and its application.

Concepts of compensation, series/parallel/ series-parallel/feedback compensation, Lag/Lead/Lag-Lead networks for compensation, compensation using P, PI, PID controllers.

[T1,T2][No. of Hrs. : 11]

**Text Books:**

- [T1] B. C. Kuo, "Automatic control system", Prentice Hall of India, 7<sup>th</sup> edition 2001.  
 [T2] Nagraath Gopal "Control Systems Engineering -Principles and Design" New Age Publishers

**Reference Books:**

- [R1] Norman S. Nise, "Control systems engineering" John Wiley & Sons (Asia) Singapore.  
 [R2] Raymond T. Stefani, Design of Feedback Control System, Oxford University Press.  
 [R3] K. Ogata, "Modern control engineering", Pearson 2002.  
 [R4] S. P. Eugene Xavier, "Modern control systems", S. Chand & Company.  
 [R5] M. Gopal "Control Systems-Principles and Design" TMH 4<sup>th</sup> Edition 2012

**COMMUNICATION SKILLS FOR PROFESSIONALS**

**Paper Code: ETHS-301**

**Paper: Communication Skills for Professionals**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>1</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To develop communication competence in prospective engineers so that they are able to communicate information as well as their thoughts and ideas with clarity and precision. This course will also equip them with the basic skills required for a variety of practical applications of communication such as applying for a job, writing reports and proposals. Further, it will make them aware of the new developments in communication that have become part of business organisations today.*

**UNIT I**

**Organizational Communication:** Meaning, importance and function of communication, Process of communication, Communication Cycle - message, sender, encoding, channel, receiver, decoding, feedback, Characteristics, Media and Types of communication, Formal and informal channels of communication, 7 C's of communication, Barriers to communication, Ethics of communication (plagiarism, language sensitivity)

**Soft Skills:** Personality Development, Self Analysis through SWOT, Johari Window, Interpersonal skills -Time management, Team building, Leadership skills. Emotional Intelligence. Self Development and Assessment- Self assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, Career planning, Self esteem.

[T1,T2][No. of Hrs. 08]

**UNIT II**

**Introduction to Phonetics:** IPA system (as in Oxford Advanced Learner's Dictionary), Speech Mechanism, The Description of Speech Sounds, Phoneme, Diphthong, Syllable, Stress, Intonation, Prosodic Features; Pronunciation; Phonetic Transcription - Conversion of words to phonetic symbols and from phonetic symbols to words. British & American English (basic difference in vocabulary, spelling, pronunciation, structure)

**Non-Verbal Language:** Importance, characteristics, types – Paralanguage (voice, tone, volume, speed, pitch, effective pause), Body Language (posture, gesture, eye contact, facial expressions), Proxemics, Chronemics, Appearance, Symbols.

[T1,T2][No. of Hrs. 08]

**UNIT III**

**Letters at the Workplace** – letter writing (hard copy and soft copy): request, sales, enquiry, order, complaint. Job Application -- resume and cover letter

**Meeting Documentation**-- notice, memo, circular, agenda and minutes of meeting.

**Report Writing** - Significance, purpose, characteristics, types of reports, planning, organizing and writing a report, structure of formal report. Writing an abstract, summary, Basics of formatting and style sheet (*IEEE Editorial Style Manual*), development of thesis argument, data collection, inside citations, bibliography; Preparing a written report for presentation and submission. Writing a paper for conference presentation/journal submission.

[T1,T2][No. of Hrs. 08]

**UNIT IV**

**Listening and Speaking Skills:** Importance, purpose and types of listening, process of listening, difference between hearing and listening, Barriers to effective listening, Traits of a good listener, Tips for effective listening. Analytical thinking; Speech, Rhetoric, Polemics; Audience analysis. Telephone Skills - making and receiving calls, leaving a message, asking and giving information, etiquettes.

**Presentations:** Mode, mean and purpose of presentation, organizing the contents, nuances of delivery, voice and body language in effective presentation, time dimension.

**Group Discussion:** Purpose, types of GDs, strategies for GDs, body language and guidelines for group discussion.

**Interview Skills:** Purpose, types of interviews, preparing for the interview, attending the interview, interview process, employers expectations, general etiquettes.

[T1,T2][No. of Hrs. 07]



**Text Books:**

- [T1] Anna Dept. Of English. Mindscapes: English for Technologists & Engineers PB. New Delhi: Orient Blackswan.
- [T2] Farhathullah, T. M. Communication Skills for Technical Students. Orient Blackswan, 2002.

**References Books:**

- [R1] Masters, Ann and Harold R. Wallace. Personal Development for Life and Work, 10th Edition. Cengage Learning India, 2012.
- [R2] Institute of Electrical and Electronics Engineers. IEEE Editorial Style Manual. IEEE, n.d. Web. 9 Sept. 2009.
- [R3] Sethi and Dhamija. A Course in Phonetics and Spoken English. PHI Learning, 1999.
- [R4] Khera, Shiv. You Can Win. New York: Macmillan, 2003.

**HEAT TRANSFER LAB****Paper Code: ETME-351****Paper: Heat Transfer Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments: Heat Transfer**

1. To determine thermal conductivity of a conducting material.
2. To determine thermal conductivity of an insulating powder.
3. To determine overall heat transfer coefficient and the temperature distribution across the width of a composite wall.
4. To determine the surface heat transfer coefficient for a heated vertical cylinder in natural convection.
5. To determine the heat transfer coefficient in forced convection of air in a tube.
6. To determine temperature distribution, efficiency and effectiveness of a pin fin.
7. To determine Stefan-Boltzman constant of radiation heat transfer.
8. To determine emissivity of a metallic plate.
9. To study boiling heat transfer phenomenon for pool boiling.
10. To study and compare the heat transfer rate, LMTD, overall heat transfer coefficient and effectiveness of a heat exchanger working in a parallel flow/counter flow mode.
11. To determine the overall heat transfer coefficient of a horizontal condenser.
12. To compare the performance characteristics of a heat pipe with two other geometrically similar pipes of copper and stainless steel.

**Reference:** R.C. Sachdeva, "Heat Transfers", McGraw Hill,**NOTE:- At least 8 Experiments out of the list must be done in the semester.**



**DYNAMICS OF MACHINES LAB****Paper Code: ETME-351****Paper: Dynamics of Machines Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. To perform experiment on watt and Porel Governor to prepare performance characteristic Curves, and to find stability and sensitivity
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. To analyse the motion of a motorized gyroscope when the couple is applied along its spin axis
4. Static and Dynamic Balancing of rotating masses.
5. Dynamic Balancing of reciprocating masses (IC engine).
6. To determine whirling speed of shaft theoretically and experimentally
7. To determine the natural frequency of undamped torsional vibration of two rotor shaft system
8. To determine the frequency of undamped free vibration of an equivalent spring mass system.
9. To determine the frequency of damped force vibration of a spring mass system

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**MACHINE DESIGN-I LAB****Paper Code: ETME-355****Paper: Machine Design-I Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>3</b>	<b>2</b>

**List of Experiments:**

The Practicals will involve design of all the elements of the following systems

1. Design of cotter joint
2. knuckle joint
3. pipe Joint
4. screw jack/ Toggle screw jack
5. Rigid and Flexible coupling
6. Spur Gear train

**NOTE:- All Experiments out of the list must be done in the semester.**

**CONTROL SYSTEMS LAB****Paper Code: ETEL-355****Paper: Control Systems Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Comparison of open loop & closed loop control in speed control of D.C. motor & to find the transfer function.
2. To study the characteristics of positional error detector by angular displacement of two servo potentiometers
  - a. excited with dc
  - b. excited with ac
3. To study synchro transmitter in terms of position v/s phase and voltage magnitude with respect to rotor voltage magnitude /phase.
4. To study remote position indicator systems using synchro transmitter/receiver.
5. To plot speed- torque curves for ac servomotor for different voltages.
6. To study ac motor position control system & to plot the dynamic response & calculate peak time, settling time, peak overshoot, damping frequency, steady state error etc.
7. To study the time response of simulated linear systems.
8. To study the performance of PID Controller.
9. Plot impulse response, unit step response, unit ramp response of any 2<sup>nd</sup> order transfer function on same graph using MATLAB.
10. To draw the magnetization (Volt Amps) characteristics of the saturable core reactor used in the magnetic amplifier circuits.
11. Plot root locus for any 2<sup>nd</sup> order system (with complex poles). For Mp=30%, find the value of K using MATLAB.
12. To design lead-lag compensator for the given process using Bode plots in MATLAB.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**COMMUNICATION SKILLS FOR PROFESSIONALS LAB**

<b>Paper Code: ETHS-351</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Communication Skills for Professionals Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**Objective:** To develop communication competence in prospective engineers so that they are able to communicate information as well as their thoughts and ideas with clarity and precision. These activities will enhance students' communication skills with a focus on improving their oral communication both in formal and informal situations. They will develop confidence in facing interviews and participating in group discussions which have become an integral part of placement procedures of most business organisations today.

**Lab Activities to be conducted:**

- 1. Listening and Comprehension Activities** – Listening to selected lectures, seminars, news (BBC, CNN, etc.). Writing a brief summary or answering questions on the material listened to.
- 2. Reading Activities** -- Reading different types of texts for different purposes with focus on the sound structure and intonation patterns of English. Emphasis on correct pronunciation.
- 3. Conversation Activities**-- Effective Conversation Skills; Formal/Informal Conversation; Addressing higher officials, colleagues, subordinates, a public gathering; Participating in a video conference.
- 4. Making an Oral Presentation**–Planning and preparing a model presentation; Organizing the presentation to suit the audience and context; Connecting with the audience during presentation; Projecting a positive image while speaking; Emphasis on effective body language.
- 5. Making a Power Point Presentation** -- Structure and format; Covering elements of an effective presentation; Body language dynamics.
- 6. Making a Speech** -- Basics of public speaking; Preparing for a speech; Features of a good speech; Speaking with a microphone. Famous speeches may be played as model speeches for learning the art of public speaking. Some suggested speeches: Barack Obama, John F Kennedy, Nelson Mandela, Mahatma Gandhi, Jawahar Lal Nehru, Atal Bihari Vajpayee, Subhash Chandra Bose, Winston Churchill, Martin Luther King Jr.
- 7. Participating in a Group Discussion** -- Structure and dynamics of a GD; Techniques of effective participation in group discussion; Preparing for group discussion; Accepting others' views / ideas; Arguing against others' views or ideas, etc.
- 8. Participating in Mock Interviews** -- Job Interviews: purpose and process; How to prepare for an interview; Language and style to be used in an interview; Types of interview questions and how to answer them.

**Suggested Lab Activities:**

1. Interview through telephone/video-conferencing
2. Extempore, Story Telling, Poetry Recitation
3. Mock Situations and Role Play; Enacting a short skit
4. Debate (Developing an Argument), News Reading and Anchoring.

**Reference Books:**

1. Patnaik, Priyadarshi. *Group Discussion and Interview Skills: With VCD*. Cambridge University Press India (Foundation Books), 2012 edition.
2. Kaul, Asha. *Business Communication*. PHI Learning: 2009.
3. Hartman and Lemay. *Presentation Success: A Step-by-Step Approach*. Thomson Learning, 2000.

**Note:** The Communication Skills Lab should be equipped with computers, microphones, an internet connection, overhead projector, screen, sound system, audio/video recording facilities, and seating arrangement for GDs and mock interviews. The student activities may be recorded and students may replay them to analyse and improve their pronunciation, tone, expressions, body language, etc.

Traditional language lab softwares are not mandatory and may be used by students to practice and enhance their language competence. Such softwares are usually elementary in nature and are mostly based on British/American English (pronunciation, accent and expression). They should preferably be in Indian English.

**MACHINE DESIGN-II**

**Paper Code: ETME-302**  
**Paper: Machine Design-II**

L	T/P	C
3	1	4

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objectives: The primary objective of this course is to demonstrate how engineering design uses the many principles learned in previous engineering science courses and to show how these principles are practically applied. The emphasis in this course is on machine design: the design and creation of devices that consist of interrelated components used to modify force and/or motion.*

**UNIT-I****Design of Elements:-**

**Mechanical Drives:** Selection of transmission, Design of helical, bevel and worm gears, ,dynamic and wear loads, selection and design of flat and V belt and roller chain drives.

**[T1,T2][No. of Hrs. 11]****UNIT II**

**Friction Clutches & Brakes:** Common friction materials, shoe, band, cone, disc brakes and clamp brakes, their characteristics and design, friction clutches.

**[T1,T2][No. of Hrs. 11]****UNIT III**

**Bearings and Lubrication:** Types of sliding bearing, materials, type of lubrication, design of sliding bearing, McKee's equation, various types of ball & roller bearings, selection and application of ball & roller bearings, seals.

**[T1,T2][No. of Hrs. 11]****UNIT IV**

**Hoisting Elements:** Wire ropes, hooks, pulleys

**Engine Parts:** Piston, connecting rod, crank shaft for single cylinder engine.

**[T1,T2][No. of Hrs. 11]****Text Books:**

[T1] Maleeve Hartman and O.P. Grover, "Machine Design", CBS Publication & Publishers.

[T2] V.B Bhandari, "Machine Design", Tata McGraw Hill.

**Reference Book:**

[R1] Mahadevan, "Design Data Book", CBS Publishers & Distributors

[R2] J.E. Shigley & C.R. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Co.Inc.

[R3] P.C. Sharma and D.K Aggarwal., "Machine Design", S.K. Kataria & Sons

[R4] Juvinal R C, Marshek K M, "Fundamentals of Machine component Design", Wiley India

[R5] Norton R. I. "Machine Design" Pearson

**METAL CUTTING & TOOL DESIGN**

<b>Paper Code: ETME-304</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Metal Cutting &amp; Tool Design</b>	<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to facilitate the student with theories in metal cutting technology and design aspects of Jigs fixtures and tooling in use today and its application in different type of Industries.*

**UNIT - I**

**Introduction:** Definition of feed, depth of cut and cutting speed. Concept of specific cutting energy in metal cutting and Numerical based on calculation of machining time on lathe, drilling machine, shaper, milling machine and grinding machines considering specific cutting energy of materials.

**Theory of Metal Cutting:** Orthogonal and oblique cutting, tool geometry (ASA & ISO), types of chips, Factors affecting the chip formation, Cutting forces in orthogonal cutting and their measurement, Merchant circle and derivation of relationships between the cutting forces, chip thickness ratio, shear angle, stress and strain in the chip, work done and power required in metal cutting and 'size effect', apparent mean shear strength of work material.

[T1,T2][No. of Hrs. 11]

**UNIT - II**

**Ernst Merchant Theory:** Ernst Merchant Theory, its assumptions and modifications. Relationship between cutting velocity, shear velocity and chip flow velocity. Mechanism of friction at chip-tool interface. Numericals based on metal-cutting. Lee & Shafer Theory – slip line method, determination of shear angle by Mohr's circle.

**Heat Generation in Metal Cutting:** Heat generation and temperature distribution in metal cutting. Calculation of temperature in primary and secondary deformation zones and their measuring methods.

[T1,T2][No. of Hrs. 11]

**UNIT - III**

**Machinability:** Machinability and its criteria, forms of tool-wear in metal cutting, tool-life and its criteria, effect of different cutting parameters on tool-life. Economics of machining and numericals. Cutting fluids, their physical action and applications.

**Grinding:** Specifications of grinding wheel, Mechanics of grinding, effect of grinding conditions and type of grinding on wheel behaviour, equivalent diameter of grinding wheel.

[T1,T2][No. of Hrs. 11]

**UNIT - IV**

**Cutting Tool Design:** General considerations, study of angle for single point cutting and drill. Principles of different cutting tool materials and their important characteristics. Geometry of a drill. Basic principles of design of a single point and multiple point tools i.e broaches and twist drill.

**Jigs & Fixtures:** Important considerations in jigs and fixture design. Main principles of designing of jigs & fixtures, elements of Jigs and fixtures. Different devices and methods of locations. Different types of clamps used in jigs & fixtures.

[T1,T2][No. of Hrs. 11]

**Text Books:**

- [T1] B.L. Juneja, G. S. Sekhon, Nitin Seth” Fundamental of Metal Cutting and Machine Tools”, New Age International 2<sup>nd</sup> edition,  
 [T2] P. H. Joshi” Jigs and Fixtures”, 2<sup>nd</sup> Edition TMH  
 [T3] G.K. Lal “Introduction to Machining Science”, New age International.

**Reference Books:**

- [R1] Geoffrey Boothroyd, “Fundamentals of Metal Machining & Machine Tools”, TMH  
 [R2] P.N. Rao, “Manufacturing Technology”, Tata McGraw Hill Publication Ltd.  
 [R3] B.J. Ranganath, “Metal Cutting & Tool Design” Vikas Publishing House Pvt. Ltd  
 [R4] A.B. Chattopadhyay “Machining and Machine Tools” Wiley India

**FLUID SYSTEMS****Paper Code: ETME-306****L T/P C****Paper: Fluid Systems****3 1 4****INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: To introduce the student about Hydraulic Turbines, Reaction Turbines, Centrifugal Pumps and Hydraulic and pneumatic circuits.*

**UNIT - I**

**Introduction:** Introduction and classification of fluid machineries; Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), jet propulsion.

**Hydraulic Turbines:** Classification of turbines, Impulse turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Governing of Pelton wheel

**[T1, T2, R1, R2, R3] [No. of Hrs. 11]****UNIT – II**

**Reaction Turbines:** Francis and Kaplan turbines, Constructional details, Velocity triangles, Power and efficiency calculations, Degree of reaction, Draft tube, Cavitations in turbines, Performance characteristics, Principles of similarity, Unit and specific speed, selection of turbines hydroelectric plants.

**Centrifugal Pumps:** Classifications and utility of various type pumps, introduction to **centrifugal Pumps**, Vector diagram, Work done by impellor, Efficiencies of centrifugal pumps, Specific speed, Model testing, Cavitations & separation and their control, Performance characteristics.

**[T1, T2, R1, R2, R3] [No. of Hrs. 11]****UNIT – III**

**Hydraulic Power and its Transmission:** Transmission of hydraulic power through pipe lines; water hammer; precautions against water hammer in turbine and pump installations.

**Power Hydraulics:** Introduction to Positive pumps (gear, vane, screw, variable delivery pumps), Different types of Valves (flow control, pressure control, direction control, solenoid operated valve)

**[T1, T2, R1, R2, R3] [No. of Hrs. 11]****UNIT – IV**

**Hydraulic systems:** Function, construction and operation of Hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic lift and hydraulic press, Fluid coupling and torque converter, Hydraulic ram

**Hydraulic and Pneumatic Circuits:** Basic principles, comparison of pneumatic and hydraulic Systems, hydraulic circuits, (meter-in, meter-out, bleed-off).

**[T1, T2, R1, R2, R3] [NO. of Hrs. 11]****Text Books:**

[T1] Dr. R.K. Bansal, “Fluid Mechanics & Hydraulic Machines”, Laxmi Publications (P) Ltd., 2002.

[T2] Jagadish Lal, “Fluid machines Including Fluid mechanics”, Metropolitan Book Co., New Delhi, 1995.

**Reference Books:**

[R1] Dr. D.S. Kumar, “Fluid Mechanics & Fluid Power Engineering”, S.K. Kataria & Sons, 2001

[R2] Kumar, K.L, “Engineering Fluid Mechanics”, Eurasia Publishing House, New Delhi, 1995.

[R3] P.N Modi and S.M Seth, “Hydraulics and Fluid Mechanics”, Standard Book House

[R4] S.K Agrawal, “Fluid mechanics and machinery”, Tata McGraw hill

[R5] D.R. Malhotra & N.K. Malhotra, “The Fluid Mech. & Hydraulics”, Satya Prakashan, 2001

[R6] Streeter & Wylie, “Fluid Mechanics”, McGraw-Hill



**REFRIGERATION & AIR CONDITIONING**

**Paper Code: ETME-308**

**Paper: Refrigeration & Air Conditioning**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to facilitate the student with the basics of Refrigeration & Air conditioning that are required for an engineering student.*

**UNIT-I**

**Introduction to Refrigeration:** Brief history of refrigeration. Concepts of various refrigeration systems, Heat Pump COP, Unit of Refrigeration,

**Air Refrigeration systems:** Bell Coleman Cycle, Dense Air System, Open Air System, Analysis of Simple Air Refrigeration Cycle for Aircraft.

**Refrigerants:** ASHRAE Nomenclature. Eco Friendly Refrigerants, Properties of Refrigerants, Introduction to Azeotropic & Non Azeotropic Refrigerant Mixtures (NARM).

[T1][T2][R3][No. of Hrs. 11]

**UNIT-II**

**Vapour Compression Refrigeration System:** Simple Saturated Cycle. T-S, P-h diagrams. COP. Dry and Wet Compression. Effect of operating parameters. Liquid-Suction Heat Exchanger. Actual vapour compression cycle.

**Compound Vapour Compression System:** Concepts of (i) Liquid Flash cooler, (ii) Flash Inter cooler. (iii) Back pressure valves. (iv) Individual Expansion valves (v) Multiple expansion valves.

**Vapour Absorption Refrigeration System:** Vapour absorption refrigeration system for NH<sub>3</sub>-H<sub>2</sub>O & LiBr-H<sub>2</sub>O. Electrolux Refrigerator.

[T1][T2][R3][No. of Hrs. 11]

**UNIT III:**

**Instruments & Controls:** Sensing and Actuating Elements, H.P and L.P cut out, Thermostat, Solenoid valve, Rotameter, Humidistat, Anemometer etc.

**Components of Refrigeration System:** Classification of compressors, Reciprocating compressor, Clearance Volume and Volumetric efficiency, Need for Multistage Compression, Different types of Condensers, Expansion devices and Evaporators.

[T1][T2][R2][No. of Hrs. 11]

**UNIT IV:**

**Psychrometry:** Brief History of Air Conditioning. Working substance in Air Conditioning system. Dalton's Law of Partial Pressures. Psychometric Properties and Psychometric Chart. Psychometric Processes, Concept of Room Sensible Heat Factor, Grand Sensible Heat Factor, Apparatus Dew point, Effective Sensible Heat Factor. High Latent Heat Load applications, Human comfort, Summer & Winter Air Conditioning.

**Heat Load Estimation:** Inside and Outside design conditions. Solar heat gain through glass and structures. Occupancy load, Lighting load and miscellaneous loads. Infiltration and Ventilation. Summary of Heat Loads. Duct Design.

[T1][T3][R3][No. of Hrs. 11]

**Text Books:**

[T1] C.P. Arora, "Refrigeration & Air Conditioning", Tata McGraw Hill Publication.

[T2] R.C. Jordand & G.B. Prister, "Refrigeration & Air Conditioning", Prentice Hall of India Publication.

**References Books:**

[R1] W.F. Stocker & J.W. Jones, "Refrigeration & Air Conditioning", Tata McGraw Hill Publication.

[R2] Manohar Prasad, "Refrigeration & Air Conditioning", Wiley Eastern.

[R3] S. Domkundwar, "A Course in Refrigeration & Air Conditioning", Dhanpat Rai & Sons



**ORGANIZATIONAL BEHAVIOUR**

**Paper Code: ETMS-310**  
**Paper: Organizational Behaviour**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: The aim of this paper is to provide managerial skills in the students.*

**UNIT-I**

**Introduction:** Concept and nature of Organizational Behaviour; Contributing disciplines to the field of O.B.; O.B. Models; Need to understand human behaviour; Challenges and Opportunities, Management functions, Tasks and responsibilities of a professional manager; Managerial skills.

[T1,T2][No of Hrs. 10]

**UNIT-II**

Individual & Interpersonal Behaviour: Biographical Characteristics; Ability; Values; Attitudes-Formation, Theories, Organization related attitude, Relationship between attitude and behaviour; Personality – determinants and traits; Emotions; Learning-Theories and reinforcement schedules, Perception –Process and errors.

[T1,T2][No of Hrs. 12]

**UNIT-III**

Organization Structure and Process: Organizational climate and culture, Organizational Structure and Design, Managerial Communication, Motivation, Stress and its management, Decision Making: Organizational Context of Decisions, Decision Making Models; Problem Solving.

[T1,T2][No of Hrs. 10]

**UNIT-IV**

Interactive Aspects of Organizational Behaviour: Interpersonal Behaviour: Johari Window; Transactional Analysis – ego states, types of transactions, life positions, applications of T.A, Group Dynamics; Management of Organizational Conflicts; Leadership Styles.

[T1,T2][No of Hrs. 12]

**Text Books:**

- [T1] Luthans Fred., “Organizational Behaviour”, McGraw Hill, 2010, 12<sup>th</sup> ed.  
[T2] Robbins & Judge (15<sup>th</sup> ed.), “Essentials of Organizational Behaviour”, Pearson 2012.

**References:**

- [R1] Stoner, R. James A.F., Edward Freeman Daniel R Gilbert Jr., Management 6TH Ed, PHI  
[R2] George, J. M. & Jones, G.R. (2009). Understanding and Managing Organizational Behaviour, 5th Edition, Pearson Education.  
[R3] Green Berg, J. and Baron, R.A. (2008), Behaviour in Organization. Prentice Hall of India.  
[R4] Mcshane, S.L., Von Glinow, M.A., Sharma, R.R. (2006) Organizational Behaviour. Tata McGrawHill

**METROLOGY****Paper Code: ETME-312****Paper: Metrology**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to facilitate the student with techniques being adopted in industry for inspection and quality checks.*

**UNIT - I**

**Principles of measurement:** Definition of Metrology, difference between precision and accuracy. Sources of errors: Controllable and Random Errors, Effects of Environment and Temperature, Effects of support, alignment errors, application of Least Square principles, errors in measurement of a quality which is function of other variables. Introduction to Coordinate Measuring Machine (CMM).

**Length Standards:** Line standards, end standards and wavelength standards, transfer from line standards to end standards. Numerical based on line standards. Slip gauges – its use and care, methods of building different heights using different sets of slip gauges.

**Limits, fits and Tolerances:** Various definitions, IS919-1963, different types of fits and methods to provide these fits. Numerical to calculate the limits, fits and tolerances as per IS 919-1963. ISO system of limits and fits; Gauges and its types, limit gauges – plug and ring gauges. Gauge Design – Taylor's Principle, wear allowance on gauges. Different methods of giving tolerances on gauges, Numericals.

**[T1,T2][No. of Hrs. 11]****UNIT - II**

**Comparators:** Mechanical Comparators: Johanson Mikrokator and Sigma Mechanical Comparator. Mechanical-optical comparator. Principles of Electrical and electronic comparators. Pneumatic comparators – advantages, systems of Pneumatic gauging:- Flow type and back pressure type, Principle of working of back pressure gauges, different type of sensitivities and overall magnification, Solex Pneumatic gauges and differential comparators. Numericals based on pneumatic comparators.

**Angular Measurement:** Sine Bar – different types of sine bars, use of sine bars in conjunction with slip gauges, precautions and calibration of sine bars. Use of angle gauges, spirit level, errors in use of sine bars. Numericals. Circular Division: dividing head and circular tables, circular division by precision Polygons. Caliper Principle, Calibration of polygons. Numerical based on circular division.

**[T1,T2][No. of Hrs. 11]****UNIT - III**

**Straightness and Flatness:** Definition of Straightness and Flatness error. Numericals based on determination of straightness error of straight edge with the help of spirit level and auto collimator. Numericals based on determination of flatness error of a surface plate with the help of spirit level or auto collimator. Surface texture, different types of irregularities, standard measures for assessment and measurement of surface finish.

**Screw Thread Measurement:** Errors in threads, Measurement of elements of screw threads –major dia, minor dia, pitch, flank angle and effective diameter (Two and three wire methods). Effect of errors in pitch and flank angles and its mathematical derivation. Numericals.

**Gear Measurement:** Measurement of tooth thickness – Gear tooth vernier caliper, Constant chord method, base tangent method and derivation of mathematical formulae for each method. Test plug method for checking pitch diameter and tooth spacing. Measurement of Gear Pitch, Parkinson Gear Tester, Numericals.

**[T1,T2][No. of Hrs. 11]****UNIT - IV**

**Machine Tool Alignment:** Machine tool tests and alignment tests on lathe. Alignment tests on milling machine. Alignment tests on a radial drilling machine.

**Interferometry:** Principle of measurement, Interferometry applied to flatness testing, surface contour tests, optical flats, testing of parallelism of a surface with the help of optical flat. Quantitative estimate of error in parallelism, Flatness Interferometer NPL-Gauge length interferometer for checking the error in slip gauges. Numericals based on Interferometry.

**Introduction to Seismic Transducers** - Displacement and acceleration measurement, Pressure measurement - Bourdon pressure gauge, bulk modulus gauge, pirani gauge.

[T1,T2][No. of Hrs. 10]

**Text Books:**

- [T1] R.K. Jain, "Engineering Metrology", Khanna Publishers, Delhi  
[T2] I.C. Gupta, "Engineering Metrology", Dhanpat Rai Publications, Delhi

**Reference Books:**

- [R1] F.W. Galyer & C.R. Shotbolt, "Metrology for Engineers", ELBS edition\  
[R2] Beckwith, Buck, Lienhard, *Mechanical Measurements*, Pearson Education\  
[R3] Anand K Bewoor, Vinay A Kulkarni "Metrology and Measurement",TMH

**MACHINE DESIGN-II LAB**

**Paper Code: ETME–352**  
**Paper: Machine Design-II Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>3</b>	<b>2</b>

**List of Experiments:**

The Practicals will involve design of all the elements of the following systems.

1. Automotive Transmission (Gear Box)
2. Brakes
3. Clutches
4. Piston of I C Engine
5. Connecting rod of I.C. Engine
6. Mechanical Hoist
7. Hydraulic Riveter
8. Passenger Lift.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**METAL CUTTING & TOOL DESIGN LAB**

**Paper Code: ETME-354**

**Paper: Metal Cutting & Tool Design Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Designing a single point cutting tool using tool grinder.
2. Measurement and analysis of cutting forces in orthogonal turning for different materials at different speeds.
3. Measurement and analysis of cutting forces in orthogonal turning for different materials at different feed and depth of cut.
4. Flank wear – time characteristics for single point cutting tools for different materials at different speeds.
5. Flank wear – time characteristics for single point cutting tools for different materials at different feed and depth of cut.
6. A study of chips formed at different speed, feed, depth of cut, for different materials.
7. (i) Checking the level of installation of a lathe in horizontal & vertical planes.  
(ii) Checking the bed ways for straightness and parallelism.
8. Testing the main spindle of a lathe for axial movement and true running.
  - a. Process capability determination of a center lathe.
  - b. Flatness checking of a surface plate.
9. A study of gear indexing mechanism and using it to cut a gear
10. Find temperature at tool chip interface.
11. Efficiency testing of lathe at various parameters-values.
12. Accuracy analysis of finished cylindrical work-pieces produced on a lathe.

**NOTE: - At least 8 Experiments out of the list must be done in the semester.**

**FLUID SYSTEMS LAB**

**Paper Code: ETME-356**  
**Paper: Fluid Systems Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**Fluid Systems Lab experiments based on syllabus (ETME-306).**

**NOTE:- At least 8 Experiments from the syllabus must be done in the semester.**



**REFRIGERATION AND AIR CONDITIONING LAB****Paper Code: ETME-358****Paper: Refrigeration and Air Conditioning Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Test on Vapour compression Test Rig.
2. Test on ice plant test rig.
3. Test on air conditioning test rig.
4. Trial on vapour absorption refrigeration system.
5. Study of installation/operation/maintenance practices for refrigeration systems.
6. Determination of refrigeration load in cold storage (case study/visit).
7. Visit to any refrigeration or air conditioning plant.
8. Thermal analysis of any refrigeration or air-conditioning cycle.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**METROLOGY LAB****Paper Code: ETME-360****Paper: Metrology Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Study & working of simple measuring instruments- Vernier calipers, micrometer, tachometer.
2. Measurement of effective diameter of a screw thread using 3 wire method.
3. Measurement of angle using sine bar & slip gauges. Study of limit gauges.
4. Study of angular measurement using level protector.
5. Adjustment of spark plug gap using feeler gauges.
6. Study of dial indicator & its constructional details.
7. Use of dial indicator to check a shape run use.
8. Study and understanding of limits, fits & tolerances
9. Study of Pressure and Temperature measuring equipment.
10. Speed measurement using stroboscope.
11. Flow measurement experiment
12. Vibration/work measuring experiment.
13. Determination of linear / Angular dimensions of a part using any other precision / non-precision measuring instruments.
14. Precision Angular measurement using Autocollimator / Angle Dekkor.
15. Machine Tool Alignment Test on any machine like-Lathe, Milling, Drilling.
16. Measurement of Screw Thread using Floating Carriage Micrometer.
17. Measurement of Gear Tooth Thickness by Gear Tooth vernier caliper/Constant Chord /Span Micrometer.
18. Measurement of Circularity / Roundness using Mechanical Comparator.
19. Calibration of Dial gauge using dial gauge Tester.
20. Study of Surfaces using optical flat.
21. Study and applications of profile projector and Tool Makers microscope.
22. Inspection of Production Job by statistical Process Control.

**NOTE: - At least 8 Experiments out of the list must be done in the semester.**



**AUTOMOBILE ENGINEERING**

**Paper Code: ETME-401**  
**Paper: Automobile Engineering**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: The objective of the paper is to introduce the student about Power plant, Transmission Systems, Clutches and its principles of friction clutch, types of suspension, Mechanical and hydraulic brakes and other automobile s engineering functions.*

**UNIT – I**

**Power Plant:** Selection of power plant for automotive vehicle, requirements of vehicle. Characteristics of various power plants (Petrol engines, Diesel engines, CNG and LPG engine.); constructional details of C.I. and S.I. engines, crank shafts, connecting rods, pistons, piston pins, piston rings, valves mechanisms, manifolds, air cleaners, mufflers, radiators and oil filters.

**Vehicular Performance:** Load, air and grade resistance; matching of engine output and demand power, performance requirements of Passenger cars, heavy duty trucks. Performance characteristics of internal combustion engines, drive effectiveness for 2 wheel and 4 wheel drive vehicles.

**[T1, T2, T3] [No. of Hrs. 12]****UNIT II**

**Transmission Systems:** Transmission requirements, general arrangement of clutch, gear box and transmission, for various combinations of front wheel, rear wheel, front engine and rear engine for 2 wheels and 4 wheels drives De-Dion drive.

**Clutches:** Principle of friction clutch, single and multi-plate clutches, centrifugal clutch and related Numericals. Friction materials. Bonding materials. Fluid fly wheel clutch.

**[T1, T2, T3] [No. of Hrs. 11]****UNIT III**

**Transmission:** Description and working of manually operated gearboxes like sliding mesh, constant mesh, synchromesh. Hydraulic torque converter and its construction, working and performance. Analysis of Semi-automatic and Automatic transmission, overdrives, Differentials and Wilson Gear Box. Construction and working of Live axles.

**Steering System:** Steering terminologies and geometry. Davis and Ackermann steering. Power steering.

**[T1, T2, T3] [No. of Hrs. 11]****UNIT IV**

**Suspension:** Types of suspension systems, Dead Axle and Independent suspension;., air suspension, shock absorbers.

**Wheels, Tyres and Brakes:.,** Mechanical and hydraulic brakes, shoe arrangements and analysis, disc brakes, braking effectiveness requirements. Concept of Anti lock brakes. Wheel and tyre requirements, Tyre dynamics.

**[T1, T2, T3] [No. of Hrs.12]****Text Books:**

- [T1] N.K. Giri, “Automotive Mechanics”, Khanna Publishers  
 [T2] R K Rajput,” A text Book on Automobile Engineering”, Laxmi publication  
 [T3] Kirpal Singh, “Automobile Engg.”, Vol. .I & II, Standard Publishers, 2004

**Reference Books:**

- [R1] Narang G.B.S., “Automobile Engg.”, Khanna Publishers  
 [R2] Srinivasan, “Automotive Engines”, Tata McGraw Hill  
 [R3] K.K. Jain & R.B. Asthana, “Automobile Engineering”, Tata McGraw Hill  
 [R4] Joseph Haitner, “Automotive Mechanics”, C.B.S. Publications

**COMPUTER INTEGRATED MANUFACTURING**

**Paper Code: ETME-403**

**Paper: Computer Integrated Manufacturing**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: To study of application of CNC in Manufacturing & Computers in planning and scheduling in Manufacturing.*

**UNIT-1**

**An overview of CNC machines:**

Need, benefits & limitations, classification of CNC machines, Constructional features of CNC machines, Design considerations of CNC machine tools, elements of CNC machine & systems, precision measuring & positioning of CNC, Function of MCU, Machining centre, Turning centre, CNC EDM, Ball screw, Bearings, Centralized lubrication systems.

**Manual part programming** - preparatory, miscellaneous functions- Fanuc, Sinumeric, Hass controls. Linear interpolation, circular interpolation, canned cycles, cycles of threading & grooving operations, tool compensation, sub-program, main program, part programming structure, work co-ordinate system, absolute & incremental commands, feed, program zero point, co-ordinate system, process planning & flow chart for part programming, scaling, rotating, mirroring, copy & special cycles for CNC lathe and milling.

[T1][T2][T3][No. of Hrs 10]

**UNIT- II**

**Functions and Components of CIM System:** Concept of CAD/CAM and CIMS; Software Technology for CIM System: Business Database System: File processing, Data Processing and Database Design, File Organization and Relational Analysis; Decision Support System, Personal / Distributed Computing and Local Area Network.

**Tooling for CNC machine:** introduction, cutting tool materials, types of cutting tools for NC machines, tool selection, ISO specification of cutting tools, different clamping system in tool holders, tooling for milling, angle plates, CNC vices, work holding devices, clamps, rotary tables.

[T1] [T2] [T3][No. of Hrs 12]

**UNIT-III**

**Planning and Scheduling Functions in CIM System:**

Aggregate Production Planning (APP), Master Production Schedule (MPS), Material Requirement Planning (MRP), Capacity Requirement Planning (CRP), Manufacturing Resource Planning (MRPII), Just-In-time Production Systems and Concept of Enterprise Resource Planning (ERP). CNC Program generation from CAD, CNC controller & motion control in CNC system. Application of CNC and recent advances in CNC machines, maintenance of CNC machine tools, CNC trainer, DNC.

[T1][T2][T3][No. of Hrs 10]

**UNIT-IV**

**Computer-Aided Process Planning:**

Approaches – Variant and Generative, Feature Classification and Recognition; Process Classifications and Selections, Machines and Tool Selection, Setting Process Parameters, Process Sheet Documentation. Programming;

**Automated Material Handling Systems and Advanced Manufacturing Systems:**

Industrial Robots, Conveyors, AGVs, Automatic Storage and Retrieval Systems; Lean Manufacturing Systems, Agile Manufacturing Systems, Reconfigurable Manufacturing Systems, Holonic Manufacturing Systems and Agent-Based Manufacturing Systems. Programming.

[T1][T2][T3][No. of Hrs 10]

**Text Books:**

- [T1] T.K. Kundra, P. N.Rao & N.K.Tiwari, "Numerical Control and Computer Aided Manufacturing", TMH  
 [T2] Mikell P. Groover, "Automation, Production Systems and Computer- Integrated Manufacturing", 2nd Edition, Prentice Hall, 2001.  
 [T3] S.K. Sinha, "CNC Programming", Galgotia Publications 2003.

**Reference Books:**

- [R1] P. Radhakrishnan, "Computer Numerical Control Machine & Computer Aided Manufacturing", New Academic Science Limited.
- [R2] U. Rembold, "Computer Integrated Manufacturing and Engineering", Addison Wesley Publishers, 1993 edition
- [R3] S. Kant Vajpayee, "Principles of Computer Integrated Manufacturing", PHI Learning Private Limited, New Delhi, 2012
- [R4] M. Adithan, B.S. Pabla, "CNC Machines", New Age
- [R5] Binit Kumar Jha, "CNC programming made Easy", Vikas Publications



**POWER PLANT ENGINEERING**

**Paper Code: ETME-405**  
**Paper: Power Plant Engineering**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of this paper is to introduce the students about the knowledge of steam generator plant, fuel handling, types of nozzles and its application, about the steam turbines and other power plants.*

**UNIT – I**

**Steam Generator Plant:** Fuel handling systems, Indian coals, combustion of coal in furnaces; Elementary boilers- Cochran, Babcock & Wilcox. High pressure heavy duty boilers, Super critical and once through boilers layout of evaporator, super heater, re-heater and economizer; dust collectors; ash disposal, fans and draft systems, fluidized bed combustion;

[T1, T2] [No. of Hrs. 11]

**UNIT – II**

**Steam Nozzles:** Application of Nozzles. Types of Nozzles. Expansion of steam through a Nozzle. Effect of friction. Critical pressure ratio. Areas at Throat & Exit for maximum discharge conditions. Performance at off-design conditions.

**Steam Turbines:** Classification. Impulse and Reaction Turbines. Compounding of steam turbines. Velocity diagrams. Conditions for maximum efficiency.. Losses in steam turbines. Reheat Factor.

**Turbine Plant:** Feed water heaters-surface and de-aerator, construction of large condensers- zoning, air cooling zone. Calculations effect of air cooling on vacuum pump rating, cooling water systems and cooling towers Feed water treatment-make up and internal conditioning. Governing of steam turbine

[T2, R1, R2] [No. of Hrs. 11]

**UNIT – III**

**Other Power Plants:** General layout of I.C. Engines and turbine power plants, types, gas turbine plants, fields of application, Nuclear power plants, power reactors and nuclear steam turbines; handling of nuclear waste and safety measures, peak load power generation methods.

[T1] [No. of Hrs. 11]

**UNIT –IV**

**Control:** Important instruments on steam generator and turbine; drum water level control, combustion control and super heat temperature control; testing of power plants and heat balance.

**Economics:** Planning for power generation in India, super thermal power plants, estimation of cost of power generation; choice of plant site.

[T1, R3] [No. of Hrs. 11]

**Text Books:**

- [T1] Arora & Domkundwar, “A course in Power Plant Engineering”, Dhanpat Rai & Sons  
 [T2] P.L.Balaney “Thermal Engineering”, Khanna Publishers.

**Reference Books:**

- [R1] R.K.Rajput “Thermal Engineering”, Laxmi Publications (P) Ltd.  
 [R2] A.S Sarao “Thermal Engineering”, Satya Prakshan.  
 [R3] Shamsheer Gautam “Power Plant Engineering” Vikas Publishing House

**OPTIMIZATION TECHNIQUES**

**Paper Code: ETME-407**  
**Paper: Optimization Techniques**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks

*Objectives: The objective of this course is to teach the students about the linear programming PERT and CPM and other numerical methods to solve various engineering problems.*

**UNIT- I**

**Linear Programming:** Mathematical Preliminaries, Formulation of the problem and solution by Graphical Method, The Simplex Method, The Big M Method.

**[T1][No. of Hrs: 10]****UNIT- II:**

**Linear Programming:** Dual problem formulation and solution, Primal and Dual Simplex Method.

**[T1][No. of Hrs: 10]****UNIT-III:**

Transportation problems & solutions, Assignment problems and its solutions by Hungarian Method.

**[T1][No. of Hrs: 10]****UNIT- IV:**

PERT and CPM, Arrow network, Time estimates, Earliest expected time, Latest allowable occurrence time, Calculation of CPM network, Floats for activities, Critical path.

**[T1][No. of Hrs: 10]****Text Books:**

[T1] Kanti Swarup, P.K. Gupta and Man Mohan: Operations Research, Sultan Chand and Sons.

**References Books:**

- [R1] G. Hadley, "Linear Programming", Narosa Publications.
- [R2] Taha H. A. "Operation Research An Introduction" Mc Milan Publishing Company, NY.
- [R3] Miller and Lieberman G. J., "Introductions of Operational Resource" Holden Day, NY.
- [R4] Kambo N. S., "Mathematical Programming Techniques", McGraw Hill.

**PREVENTIVE MAINTENANCE & CONDITION MONITORING**

<b>Paper Code: ETME-409</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Preventive Maintenance &amp; Condition Monitoring</b>	<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to facilitate the student with techniques being adopted in industry for quality control.*

**UNIT- I**

**Maintenance Policies and Preventive Maintenance:** Maintenance, Scope of Responsibilities, Types of maintenance, Maintenance planning & control, Maintainability & Availability, Failure modes and the Bath Tub Curve. Preventive maintenance, Maintenance schedules: Repair cycle, Principles and methods of lubrication, Fault Tree Analysis, Total Productive Maintenance: Methodology and Implementation.

[T1, T2][No. of Hrs: 10]

**UNIT- II**

**Principles And Practices Of Maintenance Planning:** Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability, Equipment Life cycle, Measures for Maintenance Performance: Equipments breakdowns, Mean Time Between Failures, Mean Time To Repair, Factors of availability, Maintenance organization, Maintenance economics.

[T1, T2][No. of Hrs: 10]

**UNIT- III**

**Condition Monitoring:** Condition Monitoring: Cost comparison with and without Condition Monitoring, Onload testing and off load. Methods and instruments for Condition Monitoring, Temperature sensitive tapes, Pistol thermometers, wear-debris analysis, noise vibration and harshness analysis of machines.

[T1, T2][No. of Hrs: 10]

**UNIT-IV**

**Repair methods for basic machine elements & equipment:**

Repair methods for beds, slide-ways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location. Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance.

[T1, T2][No. of Hrs: 10]

**Text Books:**

- [T1] Srivastava, S.K., “Industrial Maintenance Management”, S. Chand and Co.  
 [T2] Bhattacharya, S.N., “Installation, Servicing and Maintenance”, S. Chand and Co.

**Reference Books:**

- [R1] White, E.N., “Maintenance Planning”, Documentation, Gower Press  
 [R2] Garg, M.R., “Industrial Maintenance”, S. Chand and Co.  
 [R3] Higgins, L.R., “Maintenance Engineering Hand book”, 5th Edition, McGraw Hill  
 [R4] Armstrong, “Condition Monitoring”, BSIRSA  
 [R5] Davies, “Handbook of Condition Monitoring”, Chapman and Hall

**INTRODUCTION TO DATA SCIENCE**

**Paper Code: ETCS-411**

**Paper: Introduction to Data Science**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To introduce the students about the knowledge and overview of R or Octave statistical package, data transformation and merging, data visualization and illustration of techniques through R or Octave.*

**UNIT- I**

Overview of R or Octave statistical package, Data Pre-processing, Data Scales, Similarity and Dissimilarity measures, sampling and quantization of data, filtering, Data transformation and merging, Data visualization, PCA, Correlation, Chi-Square test. Illustration of These techniques through R, or Octave.

[T1][R2][No. of hrs. 10]

**UNIT- II**

Regression Analysis, linear, generalized, regularized regression, Cross-validation, Training and Testing data set, Overview of nonlinear regression, Overview of Ridge regression, Latent variables, Structure Equation modelling. Illustration of These techniques through R, or Octave.

[T1][R1][R2] [No. of hrs. 10]

**UNIT- III**

Forecasting, time series data analysis, Stationarity, Seasonality, recurrent models, autoregressive models. Illustration of These techniques through R, or Octave.

[T1][T2][R1][R2][No. of hrs. 10]

**UNIT- IV**

Classification, Linear discriminant analysis, overview of support vector machine, Decision trees, Clustering, Clustering techniques. Illustration of These techniques through R, or Octave.

[T1][T2][R1][R2][No. of hrs. 10]

**Text Books:**

- [T1] Runkler, Thomas A. Data Analytics: Models and Algorithms for Intelligent Data Analysis, Springer, 2012.
- [T2] Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. The elements of statistical learning. Vol. 1. New York: Springer Series in Statistics, 2001.

**References Books:**

- [R1] Zuur, Alain, Elena N. Ieno, and Erik Meesters. A Beginner's Guide to R. Springer, 2009.
- [R2] Hansen, Jesper Schmidt. GNU Octave: Beginner's Guide: Become a Proficient Octave, User by Learning this High-level Scientific Numerical Tool from the Ground Up. Packt Publishing Ltd, 2011.



**NON-CONVENTIONAL MANUFACTURING PROCESSES**

**Paper Code: ETME-413**

**Paper: Non-Conventional Manufacturing Processes**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to facilitate the student with non conventional manufacturing processes.*

**UNIT - I**

**Introduction:** Limitations of conventional manufacturing processes need of unconventional manufacturing processes & its classification and its future possibilities.

[T1][No. of Hrs. 06]

**UNIT - II**

**Unconventional Machining Process:** Principle, Working, Process parameters and applications of unconventional machining process such as Electro-Discharge machining, WEDM, Chemical machining, Electro-chemical machining, Ultrasonic machining, Abrasive jet machining, Abrasive flow machining, Water jet machining, Laser beam machining, Electron beam machining, IBM and other advanced manufacturing processes.

[T1][No. of Hrs. 15]

**UNIT – III**

**Unconventional welding processes:** Explosive welding, Cladding etc. Under water welding, Metalizing, Plasma arc welding/cutting etc.

[T1][No. of Hrs. 10]

**UNIT-IV**

**Unconventional Forming processes:** Principle, working and applications of High energy forming processes such as Explosive Forming, Electromagnetic forming, Electro Discharge forming, water hammer forming, explosive compaction etc.

**Electronic-device Manufacturing:** Brief description of Diffusion and Photo- Lithography process for electronic-device manufacturing.

[T1][No. of Hrs. 11]

**Text Books:**

[T1] P.C. Pandey & H.S. Shan, “Modern Machining Process”, Tata McGraw Hills, 2001

[T2] Amitabh Gosh and A.K. Mallik, “Manufacturing Science”, Affiliated East-West Press Pvt. Ltd., 1985.

**Reference Books:**

[R1] J.T. Black, Ronald A. Kosher DeGarmo's Materials and Processes in Manufacturing, 11th Edition , Wiley

[R2] Mikell P. Groover" Principles of Modern Manufacturing, 5th Edition SI Version , Wiley



**GEOMETRIC MODELLING AND PRODUCT DESIGN**

**Paper Code: ETME-415**

**Paper: Geometric Modelling and Product Design**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

***Objectives:** To expose students through practice-based learning to the principles and ideas related to design for the purpose of concept development, presentation and technical documentation.*

**UNIT-I**

**Data base:** Design database concept, objectives, data structures, creation of data files in application programs and relational database management system.

**Geometric modelling(Wire frame):** Requirement of Geometric Modeling, Geometric, Role of Geometry in CAD/CAM and 3-D Graphics, Types of mathematical representation of curves, wire frame models, wire frame entities, parametric representation of synthetic curves, hermite cubic splines, Bezier curves, B-spline rational curves, curve manipulation, various software modules, e.g., OS, Graphic and application module.

[T1][No. of Hrs. 11]

**UNIT II**

**Surface modelling:** Mathematical representation of surfaces, Surface model, Surface entities, surface representation, parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated cylinder

**Parametric representation of synthetic surfaces:** Hermite Bi-cubic surface, Bezier surface, B-spline surface, COONS surface, Surface manipulation- Displaying, Segmentation, Trimming, Intersection, Transformations (2D and 3D).

[T1][No. of Hrs. 11]

**UNIT III (T1)**

**Solid Modeling:** Solid representation, solid entities ,Set Theory, half spaces, Boolean Operations, Boundary representation (B-rep) Modeling, Constructive solid geometry(CSG), Sweep Representations, Spatial Occupancy Enumeration, Mechanical Tolerances, Finite element modelling and analysis and Mechanical Assembly, solid manipulation, CAD/CAM.

**Geometric Property Formulation:** Curve Length, Surface Area, Volume Calculation, Mass Calculation, Centroid Calculation.

[T1][No. of Hrs. 11]

**UNIT IV**

**Introduction Product Design:**

Definition, Design by Evolution, Design by Innovation, Essential factors of Product Design, Morphology of Design, Role of Allowance, Primary design phases and flow charting, Process capability and Tolerance in detailed design and assembly, Product strategies, Product characteristics, Designer and his role, Basic design considerations, Types of Models designed by designers

**Standards of Product Design**

International standard for product data exchanges (IGES, STEP, ACIS, DFX); Definition of fundamental geometric entities, and design/manufacturing features; Application of STEP tools.

[T1, T2][No. of Hrs. 11]

**Text Books:**

[T1] Ibrahim Zeid, "CAD/CAM Theory and Practice", Tata McGraw-Hill Publishing Company Limited, 6th Edition 1998.

[T2] A.K Chitale and R.C.Gupta, "Product Design and Manufacturing", Prentice-Hall of India (P).Ltd; 3rd edition

**Reference Books:**

[R1] P.N. Rao, "CAD/CAM Principles and Applications", Tata McGraw Hill, 2003

[R2] Ibrahim Zeid, "Mastering CAD/CAM", Tata McGraw-Hill Publishing Company Limited.

**ADVANCED MATERIAL SCIENCE AND METALLURGY****Paper Code: ETME-417****Paper: Advanced Material Science and Metallurgy**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to facilitate the student with advanced materials in use today and its application in different type of Industries.*

**UNIT - I**

Ultra light Materials and Metallic Foams -Material Definition and Processing Characterization of cellular metals Material properties.

**[T1][No. of Hrs. 11]****UNIT - II**

Bio-Materials-Classes of materials used in medicine Application of materials in medicine and dentistry various materials and coatings for implants.

**[T2][No. of Hrs. 11]****UNIT - III**

Composite material definition and classifications composite material properties and applications, piezoelectric ceramics, magnetostrictive materials, electro-rheological fluids.

**[T3][No. of Hrs.: 10]****UNIT - IV**

Coatings and High- Temperature Materials Thin Film Shape Memory Alloys for MEMS application. Introduction to Nano-engineered materials.

**[T2,T3][No. of Hrs. 10]****Text Books:**

- [T1] Handbook of Cellular metals, Production, processing, Application, Edited by Hans Peter Degischer and Brigitte Kriszt, Wiley - VCH, 2002
- [T2] Biomaterials Science, An Introduction to Materials in Medicine, Edited by B.D. Ratner, A.S. Hoffman, F.J. Schoen, and J.E.L Emons, Academic Press, second edition, 2004
- [T3] Materials Science and Engineering, An Introduction, 5th Edition, William D. Callister, Jr., John Wiley & Sons, Inc., New York, 1999, with CD-ROM.

**Reference Books:**

- [R1] Mikell P. Grover, "Fundamentals of Modern Manufacturing, Materials, Processing, and Systems", 2<sup>nd</sup> Edition, John Wiley & Sons, inc.
- [R2] L.J. Gibson, and M.F. Ashby, "Cellular Solids, Structure and Properties", 2nd Edition, Cambridge University Press, 1999.
- [R3] Ashby, M. F., Evans, A., Fleck, N. A., Gibson, L. J., Hutchinson, J. W., & Wadley, H. N. G., Metal Foams: A Design Guide, Butterworth-Heinmann, Massachusetts; 2000
- [R4] Milton Ohring, "Materials Science of Thin Films", 2<sup>nd</sup> Edition, Academic Press, 2002.
- [R5] C.T. Herakovich, "Mechanics of Fibrous Composites", John Wiley & Sons, Inc., New York, 1998.

**OPERATIONS RESEARCH****Paper Code: ETMT-427****Paper: Operations Research**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to acquaint the student with mathematical techniques being adopted in industry which help managers in decision taking.*

**UNIT-I**

**Linear Programming:** Formulation of LP Problem. Graphical method, Simplex method for maximization and minimization LP Problems. Duality in Simplex Problems,

**Queuing Theory:** Introduction to probability concept for queuing problems. Basic structure, Terminology, Classification, Birth and Death Process. Queuing Models.

[T1][No. of Hrs. 11]

**UNIT-II**

**Transportation Models:** MODI method for optimality check, North West Corner Method, Least-cost Method and Vogel's Approximation Method (VAM) for solving balanced and unbalanced transportation problems. Problems of degeneracy and maximization.

**Assignment Models:** Assignment model for maximization & minimization problems. Traveling Salesman Problems, Industrial Problems.

[T2][No. of Hrs. 11]

**UNIT-III**

**Sequencing Theory:** Processing of n-jobs through m-machines with each job having same processing order. Processing of two jobs through m-machines with each job having different processing order.

**Decision Theory:** Decision making under uncertainty and under risk, Multistage decision making, Multi criteria decision making.

[T1][No. of Hrs. 11]

**UNIT - IV**

**Network Models:** Introduction to PERT and CPM. Fundamental concept of Network models and construction of network diagrams. Activity time estimates. Critical path and project time duration. Probability of completing the project on or before specified time. Concept of Float and slack.

**Game Theory:** Two person zero-sum games. Minimax and Maximin principle. Arithmetic, Algebraic, Matrix Algebra method. Solution by Dominance, Subgame, Graphical method, Linear programming method.

[T2][No. of Hrs. 11]

**Text Books:**

[T1] Hira and Gupta "Operation Research" S. Chand Publications

[T2] H.A. Taha, "Operations Research", Prentice-Hall India, 6<sup>th</sup> Edition, 2004.**Reference Books:**[R1] S.Kalavathy, "Operations Research", Vikas Publication, 4<sup>th</sup> Edition, 2013.

[R2] N.D. Vohra, "Operations Research", Tata McGraw Hill, 2004.

[R3] Richard Bronson, Govindasami Naadimuthu, "Operations Research", Tata McGraw Hill, 2004

[R4] A.P. Verma, "Operations Research", S.K. Kataria &amp; Sons, 2004.

[R5] J.K. Sharma, "Operation Research", Macmillan India Ltd. 2005.

**DATABASE MANAGEMENT SYSTEMS**

**Paper Code: ETCS-425**

**Paper: Database Management Systems**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**Maximum Marks: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks.

*Objective: The concepts related to database, database techniques, SQL and database operations are introduced in this subject. This creates strong foundation for application data design.*

**UNIT-I : Introductory Concepts of DBMS:** Introduction and application of DBMS, Data Independence, Database System Architecture – levels, Mapping, Database users and DBA, Entity – Relationship model, constraints, keys, Design issues, E-R Diagram, Extended E-R features- Generalization, Specialization, Aggregation, Translating E-R model into Relational model.

**[T1, T2][No. of Hrs. 10]**

**UNIT-II : Relational Model:** The relational Model, The catalog, Types, Keys, Relational Algebra, Fundamental operations, Additional Operations-, SQL fundamentals, DDL,DML,DCL PL/SQL Concepts, Cursors, Stored Procedures, Stored Functions, Database Integrity – Triggers.

**[T2, R3][No. of Hrs. 10]**

**UNIT-III:** Functional Dependencies, Non-loss Decomposition, First, Second, Third Normal Forms, Dependency Preservation, Boyce/Codd Normal Form, Multi-valued Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form.

**[T2, R1][No. of Hrs. 10]**

**UNIT-IV: Transaction Management:** ACID properties, serializability of Transaction, Testing for Serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, Database recovery management.

**Implementation Techniques:** Overview of Physical Storage Media, File Organization, Indexing and Hashing, B+ tree Index Files, Query Processing Overview, Catalog Information for Cost Estimation, Selection Operation, Sorting, Join Operation, Materialized views, Database Tuning.

**[T1, T2, R2][No. of Hrs. 12]**

**Text Books:**

[T1] Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, 5<sup>th</sup> Edition, Tata McGraw Hill, 2006

[T2] Elmsari and Navathe, “Fundamentals of Database Systems”, 4th Ed., A. Wesley, 2004

**References Books:**

[R1] C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, 8<sup>th</sup> Edition, Pearson Education, 2006.

[R2] J. D. Ullman, “Principles of Database Systems”, 2nd Ed., Galgotia Publications, 1999.

## RENEWABLE ENERGY RESOURCES

**Paper Code: ETEE-419**

**Paper: Renewable Energy Resources**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Q. No. 1 rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to introduce the knowledge of upcoming and future promising area of renewable energy resources to the students, which is developing rapidly.*

### UNIT- I

Solar Energy: radiation – extra terrestrial, spectral distribution, solar constant, solar radiation on earth, measurements; solar thermal system – solar thermal power and its conversion, solar collectors, flat plate, solar concentrating collectors, - types and applications; photovoltaic (PV) technology - photovoltaic effect, efficiency of solar cells, semi-conductor materials, solar PV system, standards and applications, tracking.

[T1][No. of hrs. 10]

### UNIT- II

Wind and Small Hydropower Energy: wind data, properties, speed and power relation, power extracted, wind distribution and speed prediction, wind map of India; wind turbines and electric generators. fundamentals – types of machines and their characteristics, horizontal and vertical wind mills, elementary design principle, wind energy farms, off-shore plants; small, mini and micro hydro power plants and their resource assessment, plant layout with major components shown.

[T2][No. of hrs. 10]

### UNIT- III

Other Non-conventional Energy Sources: biomass – photosynthesis and origin of biomass energy, resources, cultivated resources, waste to biomass, terms and definitions – incineration, wood and wood waste, harvesting super tree, energy forest, pyrolysis, thermo-chemical biomass conversion to energy, gasification, anaerobic digester, fermentation, gaseous fuel; geothermal – resources, hot spring, steam system, principle of working, site selection, associated problems in development; ocean and tidal energy – principle of ocean thermal energy conversion, wave energy conversion machines, problems and limitations, fundamentals of tidal power, conversion systems and limitations; hydrogen energy – properties of hydrogen, sources, production and storage, transportation, problems for use as fuel; fuel cells – introduction with types, principle of operation and advantages.

[T1,R2][No. of hrs. 12]

### UNIT-IV

Grid Connectivity: wind power interconnection requirement - low-voltage ride through (LVRT), ramp-rate limitations, supply of ancillary services for frequency and voltage control, load following, reserve requirement, impact of connection on steady-state and dynamic performance of power system; interfacing dispersed generation of solar energy with the grid, protective relaying, islanding, voltage flicker and other power quality issues; role of non-conventional energy system in smart grid.

[T2,R3][No. of hrs. 10]

### Text Books:

- [T1] Tiwari and Ghosal, “Renewable Energy Resources: Basic Principle & Application”, Narosa Publication
- [T2] S N Bhadra ,D, Kashtra, 'Wind Electrical Systems" Oxford Publication 2014

### References Books:

- [R2] John Twidell, “Renewable Energy Sources”, Taylor and Francis
- [R3] Godfrey Boyle, “Renewable Energy: Power for a Sustainable Future”, Oxford University Press
- [R4] Ewald F. Fuchs, “Power Conversion of Renewable Energy Systems”, Springer
- [R5] B. H. Khan, “Non Conventional Energy”, Tata McGraw Hill
- [R6] D P kothari ,”Wind energy System and applications” Narosa Pub 2014

**MANAGEMENT INFORMATION SYSTEMS AND ERP**

**Paper Code: ETME-421**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**Paper: Management Information Systems and ERP**

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Q. No. 1 rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

***Objectives:** The objective of this course is to expose the students to the managerial issues relating to information systems and help them identify and evaluate various options in this regard.*

**UNIT I**

Meaning and Role of Information Systems. Types of Information Systems: Operations Support Systems, Management Support Systems, Expert Systems, and Knowledge Management Systems. Information Systems for Strategic Management: Competitive Strategy Concepts, Strategic Role of Information Systems. Integrating Information Systems with Business Strategy, Value Chain Analysis, and Strategic Information Systems Framework.

[T1,T2][No. of Hrs. 12]

**UNIT II**

Planning for Information Systems: Identification of Applications, Business Planning Systems and Critical Success Factors, Method of Identifying Applications, Risks in Information Systems. Resource Requirements for Information Systems: Hardware and Capacity Planning, Software Needs, Procurement Options – Make or Buy decisions, Outsourcing as an Option.

[T1,T2][No. of Hrs. 12]

**UNIT III**

Systems design and Development Methodologies: SDLC Approach, Prototyping, Spiral Method, End User Development. Logical and Physical Design. Evaluation of Information Systems.

[T1,T2][No. of Hrs. 10]

**UNIT IV**

Emerging Concepts and Issues in Information Systems: Supply Chain Management, Customer Relationship Management, ERP. Introduction to Data Warehousing, Data Mining and its Applications.

[T1,T2][No. of Hrs. 10]

**Text Books:**

- [T1] Kenneth Laudon and Jane Laudon (2013). Management Information Systems, Twelfth Edition, Pearson, New Delhi.
- [T2] James O'Brien, George Marakas and Ramesh Behl (2014). Management Information Systems, Tenth Edition, McGraw Hill Education, New Delhi.

**References Books:**

- [R1] Sahil Raj, "Management Information Systems", Pearson 2013
- [R2] Girdhar Joshi (2013). Management Information Systems, Oxford University Press, New Delhi.
- [R3] Effy Oz (2009). Management Information Systems, Sixth Edition, Cengage Learning, Delhi.
- [R4] Nirmalya Bagchi (2014). Management Information Systems, Vikas Publishing House, New Delhi.



**FINITE ELEMENT METHODS**

**Paper Code: ETME-423**

**Paper: Finite Element Methods**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Q. No. 1 rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objectives: The objectives of the subject are to equip the students with the Finite Element Analysis fundamentals. The study of this subject is also enabling the students to formulate the design problems into FEA and introduce basic aspects of finite element technology.*

**UNIT – I**

**Basic of Finite Element Method, Variational calculus, Integral formulation, variational methods:** Methods of weighted residuals, Approximate solution using variational method, Modified Galerkin method, Boundary conditions

**Basic Finite Element Concepts:** Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method, Axis symmetric Problems

[T1, T2][No. of Hrs. 11]

**UNIT II**

**Discrete System:**

Axial spring element, Axial bars, Torsion bars, Application in Heat transfer and Solid Mechanic Problems, Plane truss problem, software application ANSYS etc

**Beam:** Euler Beam element and its application.

[T1, T2][No. of Hrs. 11]

**UNIT III**

**Eigen value problems:** Formulation and problems

**Single value problem in 2D:** Boundary value problem, axis symmetric problems

[T1, T2][No. of Hrs. 11]

**UNIT IV**

**Numerical on 2D Solid mechanics**

Interpolation function (triangular, Quadrilateral, serendipity elements), numerical integration and modelling consideration.

[T1, T2][No. of Hrs. 11]

**Text Books:**

[T1] J N Reddy “An Introduction to finite element method” Tata Mc Graw Hill 3rd edition

[T2] S.S. Rao, “Finite Element Method In Engineering”, Pergaman Press

**Reference Books:**

[R1] O.C. ZienKiewicz, “The Finite Element Method”, Tata McGraw Hill

[R2] Larry J. Segerlind, “Applied Finite-Element Analysis”, John Wiley and Sons

[R3] Kenneth H. Huebner, “Finite Element Method for Engineers”, John Wiley and Sons

[R4] Darell W. Pepper, J.C Heinrich “The Finite Element Method” CRC press

[R5] V.Ramamurti “Finite Element Method in Machine Design”Norosa Publishing House.

**MECHATRONICS****Paper Code: ETAT-403****Paper: Mechatronics**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: Mechatronics is the combination of mechanical and electronics automation and computers. Nowadays all the mechanical machines have been made computer controlled. The Subject details the basic hardware and software elements used for proper and successful operation of various equipments. The knowledge of this subject will be helpful to students while working in industries.*

**UNIT - I**

**Mechanical Actuating Systems:** Types of motion, Degrees of freedom, constraints, Kinematic Chains, Cam, Gear and gear trains, Ratchet and pawl Belt drive, chain drive, Bearing, pre loading.

**Hydraulic & Pneumatic Actuation Systems:** Fluid power systems, hydraulic systems, Pneumatic systems, system structure and signal flow, hydraulic pumps and Pressure Control Valves and regulation, air compressors and treatment, Cylinders, Direction Control Valves, Process control valves, Rotary Actuators, Accumulators, Amplifiers, and Pneumatic Sequencing Problems.

**[T1] [T2] [No. of Hrs: 11]****UNIT - II**

**Electrical Actuation Systems:** Switching Devices, Mechanical Switches – SPST, SPDT, DPDT, keypads; Relays, Electronic sensors, Diodes, Thyristors, Transistors, solenoid operating Valve, Solenoid Operated Hydraulic and Pneumatic Valves, Electro-Pneumatic Sequencing Problems. Control of DC Motors, Permanent Magnet DC Motors, Brushless Permanent Magnet DC Motors, AC Motors and speed controls, Stepper Motors and Controls, Servo Motors.

**Digital Electronics and systems:**

Number Systems, Binary Mathematics, Boolean Algebra, Gates and Integrated Circuits Like 7408, 7402, Karnaugh Maps, Application of Logic Gates as: Parity Generators, Digital Comparators, BCD to Decimal Decoders, Flip Flops and applications, sequential logic, Microprocessor and microcontrollers, programming, instruction set, assembly language, C programming for Intel 8051 / 8082 micro-controller.

**[T1] [T2] [No. of Hrs: 11]****UNIT - III**

**Sensors, transducers and application:** Performance Terminology, Static and Dynamic Characteristics, Displacement, Position and Proximity Sensors, Potentiometer Sensors, Strain Gauge Element, LVDT, Optical Encoders, Pneumatic Sensors, Hall Effect Sensors, Tachogenerators, Strain Gauge Load Cell, Thermostats, Photo Darlington. Interfacing Sensors in Mechatronic System.

**System Interfacing and data acquisition:**

Data acquisition systems, Data loggers, SCADA, Interfacing requirements, Buffers, Darlington Pair, Handshaking, Serial and Parallel Port Interfacing, Peripheral Interface Adapters, Analog to Digital Conversion, Digital To Analog Conversion, Sample and Hold Amplifiers, Multiplexers, Time Division Multiplexing, Digital Signal Processing, Pulse Modulation, Component Interconnection and Impedance Matching, Interfacing Motor drives. Electrical power supply and protection.

**Introduction to signal conditioning:** Signal Conditioning Processes, Inverting Amplifiers, Non Inverting Amplifiers, Summing, Integrating, Differential, Logarithmic Amplifiers, Comparators, Amplifiers Error, Filtering, wheatstone Bridge, Temperature Compensation, Thermocouple Compensation,

**[T1] [T2] [No. of Hrs: 11]****UNIT - IV****Programmable logic controllers:**

Programmable logic controllers (PLC) Structure, Input / Output Processing, principles of operation, PLC versus computer, Programming Languages, programming using Ladder Diagrams, Logic Functions, Latching, Sequencing, Timers, Internal Relays And Counters, Shift Registers, Master and Jump Controls, Jumps, Data Movement, Code Conversion, Data handling and manipulation, selecting a PLC.



**Case studies:** Mechatronic approach to design, Boat Auto pilot, high speed tilting train, automatic car park system, coin counter, engine management system, autonomous mobile system, antilock brake system control, Auto-Focus Camera, Printer, Domestic Washing Machine, Optical Mark Reader, Bar Code Reader and Pick and Place robot Arm, Using PLC for extending and retracting a pneumatic piston and two pneumatic pistons in different combinations, control of vibrating machine, control of process tank, control of conveyor motor, detecting, sorting and packaging unit.

[T1] [T2] [No. of Hrs: 11]

**Text Book:**

[T1] W. Bolton, “Mechatronics – Electronic control systems in Mechanical & Electrical Engineering”, Pearson Education Ltd., 2003.

[T2] K. P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram, Mechatronics - Integrated Mechanical Electronic Systems, Wiley;

**Reference Books:**

[R1] Joji P, Pneumatic Controls, Wiley.

[R2] Dan Neculescu, Mechatronics, Pearson

[R3] David g Alciatore, Michael B Histand, “Introduction to Mechatronics and measurement systems”, McGraw Hill Education.

[R4] A Smali, F Mrad, “Mechatronics – Integrated Technologies for Intelligent Machines, Oxford Higher Education.

[R5] Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts & Application”, Tata McGraw Hill Publishing Co.Ltd., 2003.

## ROTOR DYNAMICS

**Paper Code: ETME-427**

**Paper: Rotor Dynamics**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

***Objectives:** The aim of this course is to provide a physical understanding of rotor dynamics. Rotor dynamics basically deals with the vibration characteristics of rotating machinery. Since most of these machines operate in critical services in the oil and gas industries, one has to ensure that the machines operate with a high degree of reliability. The dynamic characteristics of the turbo machinery need to be completely understood before the machine is placed in service. A basic knowledge of the underlying principles of the rotor dynamics will help in a better understanding of the behavior of rotating machinery.*

### UNIT-I

**Torsional Vibrations in Rotating Machinery:** Modelling of rotating machinery shafting, Transfer matrix analysis for free vibrations, Excitation torque, Transient response in torsional vibration, Branched systems.

**Torsional Vibrations in Reciprocating Machinery:** Modelling of the reciprocating machine systems, Free vibration calculations, Excitation torque, Forced vibration, Cyclic irregularity, Finite element analysis by consistent mass matrix, Gear elements.

[T1][No. of Hrs. 11]

### UNIT-II

**Gyroscopic Effects:** Gyroscopics of a spinning disk, Synchronous whirl of an overhung rotor, Rotor system with a coupling, Whirl speed analysis.

**Bending Critical Speeds of Simple Shafts:** Whirling of an unbalanced simple elastic rotor, Simple shafts with several disks, Transfer matrix analysis for bending critical speeds, Finite elements method, Effect of axial stiffness, Consistent mass matrix, Effect of axial torque, Effect of gear mesh stiffness.

[T1][No. of Hrs. 11]

### UNIT-III

**Rotors Mounted on Fluid Film Bearings:** Simple rotor in fluid film bearings, Transfer matrix analysis of rotors in fluid film bearings, Transfer matrix analysis of rotors by distributed elements, Dual rotor system analysis.

**Instability Due to Fluid Film Forces and Hysteresis:** Instability of rotors mounted on fluid film bearings, rigid rotor instability, Instability of a flexible rotor, Instability threshold by transfer matrix method, internal hysteresis of shafts, Instability due to negative cross-coupled stiffness, Orbital analysis by transfer matrix method.

[T1][No. of Hrs. 11]

### UNIT-IV

**Shafts with Dissimilar Moments of Area:** Stability of a shaft with dissimilar stiffness, Whirling of a shaft with dissimilar stiffness, Effect of disk unbalance, Effect of gravity on a balanced disk, Transient response by time marching technique.

**Balancing of Rotors:** Classification of rotors, rigid rotor classification and balancing criteria, balancing of rigid rotors, balancing of flexible rotors.

### Text Books:

[T1] J.S Rao, "Rotor Dynamics", New Age International Publishers.

[T2] M.I. FrisWell, "Rotor Dynamics", Cambridge University Press

### Reference Books:

[R1] John Vance, Fouad Zeidan, Brian Murphy "Machinery Vibration and Rotor Dynamics" John Wiley & Sons

**ARTIFICIAL INTELLIGENCE****Paper Code: ETCS-429****Paper: Artificial Intelligence**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To learn the basics of designing intelligent agents that can solve general purpose problems, represent and process knowledge, plan and act, reason under uncertainty and can learn from experiences*

**UNIT-I****Introduction:** Introduction to intelligent agents**Problem solving:** Problem formulation, uninformed search strategies, heuristics, informed search strategies, constraint satisfaction solving problems by searching, state space formulation, depth first and breadth first search, iterative deepening**[T1, T2][No. of hrs. 12]****UNIT-II****Logical Reasoning:** Logical agents, propositional logic, inferences, first-order logic, inferences in first order logic, forward chaining, backward chaining, unification, resolution**[T1, T2][No. of hrs. 10]****UNIT-III****Game Playing:** Scope of AI -Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems, AI techniques- search knowledge, abstraction**[T1, T2][No. of hrs. 12]****UNIT-IV****Learning from observations:** Inductive learning, learning decision trees, computational learning theory, Explanation based learning**Applications:** Environmental Science, Robotics, Aerospace, Medical Sciences etc.**[T1, T2][No. of hrs. 10]****Text Book:**

[T1] Rich and Knight, "Artificial Intelligence", Tata McGraw Hill, 1992

[T2] S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Edu.

**Reference Books:**

[R1] KM Fu, "Neural Networks in Computer Intelligence", McGraw Hill

[R2] Russel and Norvig, "Artificial Intelligence: A modern approach", Pearson Education

**COMPUTATIONAL FLUID DYNAMICS**

**Paper Code: ETME-411**

**Paper: Computational Fluid Dynamics**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

**Objective:** To learn about the applications of Heat Conduction, Convection Heat Transfer and governing differential equations and finite difference method and applications of computational Fluid Dynamics with computer graphics in CFD.

**UNIT - I**

**Governing Differential Equations and Finite Difference Method-** Classification of PDEs, Initial and Boundary conditions, Initial and Boundary value problems, Finite difference method Central, Forward, Backward difference for a uniform grid, Central difference expressions for a non-uniform grid, Numerical error, Accuracy of solution, Grid independence test.

[T1, T2, R1, R2] [No. of Hrs. 11]

**UNIT – II**

**Conduction Heat Transfer- Applications of Heat conduction-** Steady and Unsteady conductions, One dimensional steady state problems, Two dimensional steady state problems, Three dimensional steady state problems, Transient one dimensional problems,

**Convection Heat Transfer- Introduction-** Steady one dimensional Convection, Diffusion, Unsteady one. Dimensional Convection – Diffusion – Unsteady two dimensional, Convection, Diffusion.

[T1, T2, R1, R2][No. of Hrs. 11]

**UNIT – III**

**Incompressible Fluid Flow, Introduction-** Governing equations, Difficulties in solving, Navier- Stokes equation, Stream function, Vorticity method, In viscid flow (steady) Determination of pressure for viscous flow.

[T1, T2, R1, R2][No. of Hrs. 11]

**UNIT – IV**

Applications of Computational Fluid Dynamics, Computer graphics in CFD, Future of CFD, Enhancing the design process, understanding, Applications, Automobile, Engine, Industrial, Civil, Environmental.

[T1, T2, R1, R2][No. of Hrs. 11]

**Text Books:**

[T1] Muralidhar, K., and Sundararajan, T., “Computational Fluid flow and Heat Transfer”, Narosa Publishing House,

[T2] Ghoshdasdidar, P.S., “Computer simulation of flow and heat transfer”, Tata McGraw – Hill, New Delhi

**Reference Books:**

[R1] Anderson, D. A., Tannehill, J. L., and Pletcher, R.H., “Computational fluid mechanics and Heat Transfer”, Hemisphere Publishing Corporation,

[R2] John David Anderson, "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill, New York

**SOCIOLOGY AND ELEMENTS OF INDIAN HISTORY FOR ENGINEERS**

**Paper Code: ETHS-419**

**L T/P C**

**Paper: Sociology and Elements of Indian History for Engineers**

**3 0 3**

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of this course is to familiarize the prospective engineers with elements of Indian history and sociological concepts and theories by which they could understand contemporary issues and problems in Indian society. The course would enable them to analyze critically the social processes of globalization, modernization and social change. All of this is a part of the quest to help the students imbibe such skills that will enhance them to be better citizens and human beings at their work place or in the family or in other social institutions.*

**UNIT I**

*Module 1A: Introduction to Elements of Indian History: What is History? History Sources-Archaeology, Numismatics, Epigraphy & Archival research; Methods used in History; History & historiography.*

[3 Lectures]

*Module 1B: Introduction to sociological concepts-structure, system, organization, social institution, Culture social stratification (caste, class, gender, power). State & civil society.*

[7 Lectures]

[T1][No. of Hrs. 10]

**UNIT II**

*Module 2A: Indian history & periodization; evolution of urbanization process: first, second & third phase of urbanization; Evolution of polity; early states of empires; Understanding social structures-feudalism debate.*

[3 Lectures]

*Module 2B: Understanding social structure and social processes: Perspectives of Marx, Weber & Durkheim.*

[7 Lectures]

[T1][No. of Hrs. 10]

**UNIT III**

*Module 3A: From Feudalism to colonialism-the coming of British; Modernity & struggle for independence.*

[3 Lectures]

*Module 3B: Understanding social structure and social processes: Perspectives of Marx, Weber & Durkheim.*

[9 Lectures]

[T1][No. of Hrs. 12]

**UNIT IV**

*Module 4A: Issues & concerns in post-colonial India (upto 1991); Issues & concerns in post-colonial India 2<sup>nd</sup> phase (LPG decade post 1991).*

[3 Lectures]

*Module 4B: Social change in contemporary India: Modernization and globalization, Secularism and communalism, Nature of development, Processes of social exclusion and inclusion, Changing nature of work and organization.*

[10 Lectures]

[T1][No. of Hrs. 13]

**Text Books:**

[T1] Desai, A.R. (2005), Social Background of Indian Nationalism, Popular Prakashan.

[T2] Giddens, A (2009), Sociology, Polity, 6<sup>th</sup> Edition

**Reference Books:**

[R1] Guha, Ramachandra (2007), India After Gandhi, Pan Macmillan

[R2] Haralambos M, RM Heald, M Holborn, (2000), Sociology, Collins

**AUTOMOBILE ENGINEERING LAB**

**Paper Code: ETME-451**  
**Paper: Automobile Engineering Lab**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>0</b>	<b>2</b>	<b>1</b>

Automobile Engineering Lab experiments based on syllabus (ETME-401).

**NOTE: - At least 8 Experiments from the syllabus must be done in the semester.**



**COMPUTER INTEGRATED MANUFACTURING LAB**

<b>Paper Code: ETME-453</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Computer Integrated Manufacturing Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. To study the characteristic features of CNC machine.
2. Part programming (in word address format) experiment for turning operation (including operations such as grooving and threading) and running on CNC machine.
3. Part programming (in word address format or ATP) experiment for drilling operation (point to point) and running on CNC machine.
4. Part programming (in word address format or ATP) experiment for milling operation (contouring) and running on CNC machine.
5. Experiment on Robot and programs.
6. Experiment on Transfer Line/Material Handling.
7. Experiment on difference between ordinary and NC machine, study or retrofitting.
8. Experiment on study of system devices such as motors and feedback devices.
9. Experiment on Mechatronics and Controls.

**NOTE: At least 8 Experiments out of the list must be done in the semester.**

**PREVENTIVE MAINTENANCE & CONDITION MONITORING LAB**

<b>Paper Code: ETME-455 (ELECTIVE)</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Preventive Maintenance &amp; Condition Monitoring Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. To verify the various statistical relationships from the results of observations of 200 drawings from the Shewhart's Normal Bowl containing 998 chips and to fit a normal curve by making a histogram from the individual observations. Take a subgroup of 5. The given statistical relationships are:
2.  $\bar{X}' = \bar{X}$        $\sigma' = \sigma_{\bar{X}} \sqrt{n}$        $\sigma' = \bar{R}/d_2$        $\sigma' = \bar{\sigma} / c_2$        $\sigma' = \sigma_{\sigma} / c_5$
3. To plot and determine the given unknown distribution from the results of observations of 180 drawings from the given bowl containing 778 chips. Take a sample size of 4.
4. To determine the process capability of the manual sheet metal cutting process by cutting 80 rectangular pieces (length = 30 mm & breadth = 25 mm) from 28 gauge G. I. sheet. Take a subgroup size of 5.
5. To plot p and np charts from the observations of 20 samples of 100 each drawn from the population of 3000 balls containing 5% defective balls.
6. To plot the  $\bar{X}$ , R &  $\sigma$  control charts from the observations of 120 drawings from the Shewhart Normal Bowl containing 998 chips having population parameters as  $\bar{X}' = 30$  and  $\sigma' = 9.954$ , Take a subgroup size of 5.
7. To state and prove the Central Limit Theorem. Take 180 observations from the Shewhart's Normal Bowl and take a sample size of 4.
8. To design a 2% A.O.Q.L single sampling plan by inspecting a population of 3000 balls submitted in 10 lots of 300 balls each with a process average as 0.3% to 3.0% in steps of 0.3%.
9. To plot control chart for c from the observations of 24 sample items drawn from population of 110 items.
10. To design a sequential sampling plan in which the producer's risk of rejecting the lots containing 5% defectives is 4% and the consumer's risk of accepting the lots containing 30% defectives is 20%. Use the designed sampling plan to inspect a population having process average 6% to 30% in steps of 6%. The maximum number of pieces to be inspected is 24.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**



**NON-CONVENTIONAL MANUFACTURING PROCESSES LAB**

<b>Paper Code: ETME-455 (ELECTIVE)</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Non-Conventional Manufacturing Processes Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Study of electric discharge machining process.
2. Determination of material removal rate on electric discharge machine (EDM).
3. Determination of surface roughness on EDM.
4. Study of electrochemical machining process.
5. Determination of material removal rate on electro chemical machine (ECM).
6. Determination of surface roughness on ECM.
7. Study of plasma arc welding(PAW) process
8. Determination of heat affected zone in plasma arc welding process.
9. Study the effect of current on material removal rate in EDM.
10. Study of the effect of different tool material on material removal rate in EDM.
11. Study the effect of current on surface finish rate in EDM.
12. Study of the effect of different tool surface finish on surface finish in EDM.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**ADVANCED MATERIAL SCIENCE AND METALLURGY LAB**

<b>Paper Code: ETME-455(ELECTIVE)</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Advanced Material Science and Metallurgy Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Making a plastic mould for small metallic specimen.
2. Specimen preparation for micro structural examination-cutting, grinding, polishing, etching.
3. Grain Size determination of a given specimen.
4. Comparative study of microstructures of different given specimens (mild steel, a. Gray C.I., brass, copper etc.)
5. Effect of annealing, normalizing and hardening on hardness of the specimen.
6. Effect of annealing, normalizing and hardening on toughness of the specimen.
7. Effect of case hardening on the hardness of the specimen.
8. Material identification of, say, 50 common items kept in a box.
9. Faradays law of electrolysis experiment.
10. Study of corrosion and its effects.
11. Study of microstructure of welded component and HAZ Macro & Micro Examination.
12. Suitable experiment on Magnetic/ Electrical/Electronic materials.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**DATABASE MANAGEMENT SYSTEMS LAB**

<b>Paper Code: ETME-455(ELECTIVE)</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Database Management Systems Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**LAB BASED ON DBMS**

Lab includes implementation of DDL, DCL, DML i.e SQL in Oracle.

**List of Experiments:**

1. Design a Database and create required tables. For e.g. Bank, College Database
2. Apply the constraints like Primary Key, Foreign key, NOT NULL to the tables.
3. Write a SQL statement for implementing ALTER, UPDATE and DELETE
4. Write the queries to implement the joins
5. Write the queries for implementing the following functions: MAX (), MIN (),AVG (),COUNT ()
6. Write the queries to implement the concept of Integrity constrains
7. Write the queries to create the views
8. Perform the queries for triggers
9. Perform the following operation for demonstrating the insertion, updation and deletion using the referential integrity constrains

**TEXT BOOK:**

1. SQL/ PL/SQL, The programming language of Oracle, Ivan Bayross, 4th Edition BPB Publications

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**OPERATIONS RESEARCH LAB**

**Paper Code: ETME-455(ELECTIVE)**

**L      T/P      C**

**Paper: Operations Research Lab**

**0      2      1**

**List of Experiments:**

1. To study the working of TORA software package.
2. To solve the given Linear Programming Problem by simplex method manually and TORA software package.
3. To solve the given Transportation Problem manually and TORA software package.
4. To solve the given Problem of CPM and PERT by manually and TORA software package.
5. To solve the given Queuing Theory Problem manually and TORA software package.
6. Make a program in C++ for the Formulation of Linear Programming Problem.
7. Make a program in C++ to make the 1<sup>st</sup> Simplex Table for the given Linear Programming Problem.
8. Make a program in C++ for the conversion of Primal into Dual form of Linear Programming Problem.
9. Make a program in C++ to find the basic feasible solution of the given Transportation Problem using North West Corner Rules or by least cost method.
10. Make a program in C++ to find the optimal solution of the given Assignment Problem.
11. Make a program in C++ to solve the given Queuing Theory Problem of model 1.
12. Make a program in C++ to solve the given n job 2-machine sequencing problem.
13. Make a program in C++ to give the critical path for the given network problem.
14. Make a program in C++ to find the Saddle Point of the given game programming problem.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**MECHATRONICS LAB****Paper Code: ETME-455(ELECTIVE)****L****T/P****C****Paper: Mechatronics Lab****0****2****1****List of Experiments:**

1. Study of DC valves and actuators and develop pneumatic circuits to sequence A+A-,A+B+A-B-;
2. Develop Electro –pneumatic sequencing circuits in sequence - A+A-, A+B+A-B-;
3. Develop pneumatic circuits to sequence A+A- B+B-, A+B+C+A-B-C-; A+B+B-A-;
4. Develop Electro –pneumatic sequencing circuits in sequence - A+A-B+B-; A+B+B-A-;
5. Study a simulation software for simulating ladder diagram for a PLC and make AND/OR/NAND/ NOR / XOR logic.
6. Simulate ladder diagram on a PLC software for using flags, latch(s), timer(s), counter(s), registers.
7. Wire an industrial PLC and program it for AND/ OR/ NAND / XOR logic.
8. Wire and industrial PLC and program for using flags, latch(s), timer(s),counter(s),Integers.
9. Program a 8051 / 8052 microcontroller to use input and output ports;
10. Program a 8051 / 8052 microcontroller to run a stepper motor;
11. Program a 8051 / 8052 microcontroller to use a dc motor;
12. Program a 8051 / 8052 microcontroller to use a servo motor;
13. Introduction to SCADA and HMI programming

**NOTE:- At least 8 Experiments from the syllabus must be done in the semester.**

**COMPUTATIONAL FLUID DYNAMICS LAB**

<b>Paper Code: ETME-455(ELECTIVE)</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Computational Fluid Dynamics Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

CFD softwares as per the theory syllabus such as ANSYS etc.

**NOTE:- At least 8 Experiments from the syllabus must be done in the semester.**



**ADVANCED CONTROL SYSTEMS LAB**

<b>Paper Code: ETAT-455(ELECTIVE)</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Advanced Control Systems Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

1. Study of open loop and closed loop time/ frequency responses of first/second order LTI system
2. Conversion of transfer functions to state model of LTI system and vice versa
3. Determine State Space Model of a given system and determine its controllability and observability.
4. Analysis of Zero order hold and first order hold circuits.
5. Conversion of transfer functions to state model of discrete time system.
6. To determine state transition matrix of a given system.
7. Study of saturation and dead zone non-linearity using describing function technique of a relay control system.
8. To draw phase trajectory of a given non-linear system.
9. Experiments based on PLC applications e.g. Lift control models, pick and place module etc.
10. Study of operation of a stepper motor interface with microprocessor.

**NOTE:- At least 8 Experiments from the syllabus must be done in the semester.**

**ENGINEERING SYSTEM MODELLING AND SIMULATION**

<b>Paper Code: ETME-402</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Engineering System Modeling and Simulation</b>	<b>3</b>	<b>1</b>	<b>4</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To introduce the students about the knowledge of basic and dynamic system models of engineering and simulation system.*

**UNIT - I**

**Basic System models:** Mathematical models, Mechanical system building blocks, Electrical system building block, fluid system building block, thermal system building block.

**System Models:** Engineering systems, Rotational translational systems, Electro-mechanical systems, linearity, Hydraulic Mechanical systems.

**Dynamic Response of Systems:**

Modelling dynamic systems, Terminology, First order systems, Second order systems, performance measure of second order systems, system identification.

**System Transfer Functions:**

The transfer function, first order systems, second order systems, systems in series, systems with feedback loops, effect of pole location on transient response.

[T1][No. of Hrs. 12]

**UNIT – II**

**Mechanical Event Simulation (Finite Element modelling and Analysis):**

Introduction, General procedure of finite element method, finite element analysis, iso-parametric evaluation of element matrices, finite element modelling, mesh generation, design and engineering applications. Introduction to Pro E software - Mechanica & dynamic simulation module.

[T2][No. of Hrs. 12]

**UNIT – III**

**System Simulation:**

Introduction, Review of probability and statistics, Managing the event calendar in a discrete event simulation model, Modelling input data.

[T3][No. of Hrs. 10]

**UNIT – IV**

Generation of random numbers and variates, generic features and introduction to Arena Software, Real world applications of simulation, Discrete continuous simulation, verification and validation of simulation models.

[T3][No. of Hrs. 10]

**Text Book:**

- [T1] W. Bolton, “Mechatronics – Electronic control systems in Mechanical & Electrical Engineering”, Pearson Education Ltd.
- [T2] Ibrahim Zeid, “CAD/CAM Theory and Practice”, Tata McGraw-Hill Publishing Company Limited.
- [T3] Sankar Sengupta, System Simulation and modelling, Pearson.

**Reference Books:**

- [R1] Deo, Narsingh, Millican Charles E.,”System Simulation With Digital Computer”, PHI.
- [R2] Gordon, Geoffrey, System Simulation, PHI.
- [R3] P. Radhakrishnan, S Subramanyan, V. Raju, CAD/CAM/CIM, New Age International Publishers.



**STATISTICAL QUALITY CONTROL AND RELIABILITY**

<b>Paper Code: ETME-404</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Statistical Quality Control and Reliability</b>	<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: The objective of the paper is to facilitate the student with techniques being adopted in industry for quality control.*

**UNIT - I**

**Introduction:** Definition and Need of quality, Aspects of quality, Quality characteristic, Quality specification, Quality function, Economics of quality. Inspection, Its objectives and types, Inspection versus Quality Control, Statistical Quality Control, its Tools, Advantages, limitations and Applications.

**Probability & Statistics:** Definition, Laws, Probability Distributions (Normal Binomial, Poisson, Exponential) & related problems. Measures of Central tendency & Dispersion, Concept of Variation, Variable and attribute data, Frequency distribution.

[T1, T2][No. of Hrs. 11]

**UNIT - II**

**Control Charts:** Concept of variability, Assignable and chance causes, Concept of specifications and tolerances, Definition and objectives of control charts, Control charts for variables and attributes and related problems, Variable charts vs attribute charts, Patterns on control charts, Type-I & Type-II Errors, Process capability and its methods of determination.

[T1, T2][No. of Hrs. 10]

**UNIT - III**

**Acceptance Sampling:** Definition, Advantages over 100% inspection, Methods of taking samples, Operating characteristics curve & its characteristics. Single, Double and Multiple, Sequential Sampling Plan & Related problems.

**Quality Assurance:** Need, Principles, Essentials and Advantages of Quality Assurance System, Quality Manual, Field complaints, Quality Audit & its types, Quality Assurance Methods, Quality Control vs Quality Assurance.

[T1, T2][No. of Hrs. 10]

**UNIT - IV**

**Quality systems:** Description of ISO: 9000 series of standards, ISO: 9001–2000 Systems. Description of TQM, Concept of Quality Circles, JIT System, Taguchi's Concept of Quality, Zero Defect Concept, 6 $\sigma$  Concept and 5S.

**Reliability:** Definitions of Reliability Failure, Elements of reliability. Quality vs reliability, System Reliability & related problems. Causes of failures, Constant Failure rate, MTBF, Bath Tub Curve.

[T1, T2][No. of Hrs. 11]

**Text Books:**

- [T1] M. Mahajan, "Statistical Quality Control", Dhanpat Rai & Co.  
 [T2] Amitav Mitra, "Fundamentals of Quality Control", Pearson Education

**Reference Books:**

- [R1] EL Grant & RS Leavenworth, "Statistical Quality Control", McGraw Hill & Co.  
 [R2] Feigenbaum, "Total Quality Control", McGraw Hill & Co.  
 [R3] Montgomery DC, "Introduction to Statistical Quality Control", John Wiley & Sons Inc.  
 [R4] Stephan B. Vardeman, J Marcus Jobe, "Statistical QA Methods for Engineers", John Wiley & Sons Inc.  
 [R5] Taylor J.R., "Quality Control systems", McGraw Hill Int. Education

**HUMAN VALUES & PROFESSIONAL ETHICS – II****Paper Code: ETHS-402****Paper : Human Values & Professional Ethics-II**

L	T	C
1	0	1

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.
3. Two internal sessional test of 10 marks each and one project report\* carrying 5 marks.

**Objectives:**

1. *The main object of this paper is to inculcate the skills of ethical decision making and then to apply these skills to the real and current challenges of the engineering profession.*
2. *To enable student to understand the need and importance of value-education and education for Human Rights.*
3. *To acquaint students to the National and International values for Global development*

**UNIT I - Appraisal of Human Values and Professional Ethics:**

**Review of Universal Human Values:** Truth, Love, Peace, Right conduct, Non violence, Justice and Responsibility. Living in harmony with 'SELF', Family, Society and Nature. Indian pluralism - the way of life of Islam, Buddhism, Christianity, Jainism, Sikhism and Hinduism, Greek - Roman and Chinese cultural values.

Sensitization of Impact of Modern Education and Media on Values:

- a) Impact of Science and Technology
- b) Effects of Printed Media and Television on Values
- c) Effects of computer aided media on Values (Internet, e-mail, Chat etc.)
- d) Role of teacher in the preservation of tradition and culture.
- e) Role of family, tradition & community prayers in value development.

**Review of Professional Ethics:** Accountability, Collegiality, Royalty, Responsibility and Ethics Living. Engineer as a role model for civil society, Living in harmony with 'NATURE', Four orders of living, their inter-correctness, Holistic technology (eco-friendly and sustainable technology).

[T1] [T2] [R1] [R5] [R4][No. of Hrs. 03]

**UNIT II – Engineers responsibility for safety:**

Safety and Risks, Risk and Cost, Risk benefit analysis, testing methods for safety. Engineer's Responsibility for Safety Social and Value dimensions of Technology - Technology Pessimism – The Perils of Technological Optimism – The Promise of Technology – Computer Technology Privacy

**Some Case Studies:** Case Studies, BHOPAL Gas Tragedy, Nuclear Power Plant Disasters, Space Shuttle Challenger, Three Mile Island Accident, etc.

[T1] [T2] [R4] [R2][No. of Hrs. 03]

**UNIT III – Global Issues:**

**Globalization and MNCs:** International Trade, Issues,

**Case Studies:** Kellogg's, Satyam, Infosys Foundation, TATA Group of Companies

**Business Ethics:** Corporate Governance, Finance and Accounting, IPR.

**Corporate Social Responsibility (CSR):** Definition, Concept, ISO, CSR.

**Environmental Ethics:** Sustainable Development, Eco-System, Ozone depletion, Pollution.

**Computer Ethics:** Cyber Crimes, Data Stealing, Hacking, Embezzlement.

[T1] [T2] [R4][No. of Hrs. 05]

**UNIT IV - Engineers Responsibilities and Rights and Ethical Codes:**

Collegiality and loyalty, Conflict of interests, confidentiality, occupational crimes, professional rights, responsibilities. To boost industrial production with excellent quality and efficiency, To enhance national economy, To boost team spirit, Work Culture and feeling of job satisfaction, National integration, Examples of some illustrious professionals.

Need for Ethical Codes, Study of some sample codes such as institution of Electrical and Electronics Engineers, Computer Society of India etc., Ethical Audit.

**Development and implementation of Codes:** Oath to be taken by Engineering graduates and its importance\*\*,

[T1] [T2] [R4][R2][No. of Hrs. 05]

**Text Books:**

- [T1] Professional Ethics, R. Subramanian, Oxford University Press.  
 [T2] Professional Ethics & Human Values: Prof. D.R. Kiran, TATA Mc Graw Hill Education.

**References Books:**

- [R1] Human Values and Professional Ethics: R. R. Gaur, R. Sangal and G. P. Bagaria, Eecel Books (2010, New Delhi). Also, the Teachers" Manual by the same author  
 [R2] Fundamentals of Ethics, Edmond G. Seebauer & Robert L. Barry, Oxford University Press  
 [R3] Values Education: The paradigm shift, by Sri Satya Sai International Center for Human Values, New Delhi.  
 [R4] Professional Ethics and Human Values – M.Govindrajan, S.Natarajan and V.S. Senthil Kumar, PHI Learning Pvt. Ltd. Delhi  
 [R5] A Textbook on Professional Ethics and Human Values – R.S. Naagarazan – New Age International (P) Limited, Publishers New Delhi.  
 [R6] Human Values & Professional Ethics- S B Gogate- Vikas publishing house PVT LTD New Delhi.  
 [R7] Mike Martin and Roland Schinzinger, "Ethics in Engineering" McGraw Hill  
 [R8] Charles E Harris, Micheal J Rabins, "Engineering Ethics, Cengage Learning  
 [R9] PSR Murthy, "Indian Culture Values and Professional Ethics", BS Publications  
 [R10] Caroline Whitback< Ethics in Engineering Practice and Research, Cambridgs University Press  
 [R11] Charles D Fleddermann, "Engineering Ethics", Prentice Hall.  
 [R12] George Reynolds, "Ethics in Information Technology", Cengage Learning  
 [R13] C, Sheshadri; The Source book of Value Education, NCERT  
 [R14] M. Shery; Bhartiya Sanskriti, Agra (Dayalbagh)

\*Any topic related to the experience of the B.Tech student in the assimilation and implementation of human values and professional ethics during the past three years of his/her studies in the institute OR A rigorous ethical analysis of a recent case of violation of professional ethics particularly related to engineering profession.

\*\*All students are required to take OATH in writing prior to submission of major project and the record of the same is to be maintained at the college level and/or, this oath may be administered by the head of the institutions during the graduation ceremonies. The draft for the same is available alongwith the scheme and syllabus.

### OATH TO BE TAKEN BY ENGINEERING GRADUATES

In a manner similar to the Hippocratic Oath taken by the medical graduates, Oath to be taken by the engineering graduates is as given below.

1. I solemnly pledge myself to consecrate my life to the service of humanity.
2. I will give my teacher the respect and gratitude, which is their due.
3. I will be loyal to the profession of engineering and be just and generous to its members.
4. Whatever project I undertake, it will be for the good of mankind.
5. I will exercise my profession solely for the benefit of humanity and perform no act for criminal purpose and not contrary to the laws of humanity.
6. I will keep away from wrong, corruption and avoid tempting others to vicious practices.
7. I will endeavor to avoid waste and consumption of non-renewable resources.
8. I will speak out against evil and unjust practices whenever and wherever I encounter them.
9. I will not permit considerations of religion, nationality, race, party politics or social standing to intervene between my duty and my work, even under threat.
10. I will practice my profession with conscience, dignity and uprightness.
11. I will respect the secrets, which are confided to me.

I make these promises solemnly, freely and upon my honor.

(Name of the Student)

**Correspondence Address:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Email:** \_\_\_\_\_

**NUCLEAR POWER GENERATION AND SUPPLY**

**Paper Code: ETME-408**

**Paper: Nuclear Power Generation and Supply**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks

*Objective: To introduce the students about the knowledge of nuclear power generation and supply, reactor design and nuclear power plant.*

**UNIT- I:**

**Introduction:** Systems in nuclear reactor- Reactor fuels: Natural and enriched fuels, sources, merits and demerits of different fuels for reactor use, fabrication, handling of fuels and irradiated fuels, fuel management, storage, reprocessing of irradiated fuels. Reactor shutdown systems: Materials for reactor control and choices, liquid vs. solid shut down systems, design aspect- fall safe features, loading consideration, actuation methodology. Primary heat transport (cooling) system: Heat generation and distribution, Coolant characteristics, Selection of coolants, Coolant Circuit, Core thermal hydraulics, design aspects, radioactivity generation. Decay heat removal system: Functional requirements, cooling circuits, Design aspects, Loading considerations, Passive features.

[T1, T2, R1, R2][No. of Hrs. 11]

**UNIT- II:**

**Reactor structure:** Core composition, Reflector, Reactor vessel, Safety vessel, Shielding. Thermal, biological, Shield cooling system, Neutron flux monitoring and control, instrumentations. Moderator system: Materials, Selection, Design consideration, Circuit, Radioactivity aspects. Cover gas system: Purpose, Selection of material, Design considerations, Circuit. Reactor regulating system: Purpose, Methodology, Design considerations, Actuating mechanism. Auxiliary cooling circuit: Functions, Design considerations, cooling circuit. Containment and ventilation system: Functions, Types, Arrangement, Design considerations, loading, Testing.

[T1, T2, R1, R2][No. of Hrs. 11]

**UNIT- III:**

**Reactor Design:** Principles, Safety classifications, Seismic quality group, Loading considerations under normal operations, anticipated operational occurrences, design basis accidents such as earthquake, loss of coolant accident (LOCA), blackout, flood, missiles, operator error, duel failures as applicable, Safety features for server accidents, standards, soft ware, verifications etc.

**Nuclear power plants:** Types .Thermal reactors: BWR, PWR, PHWR, GCR, APWR, AHWR etc. Fast reactors Breeders; Fusion power; Off-land NPPs:- space power unit, nuclear ships, submarines. Economics of NPPs: Various costs, ROI, Sizing, Operational characteristics.

[T1, T2, R1, R2][No. of Hrs.12]

**UNIT- IV:**

**Radiation protection and Radioactive Waste Management:** Radiation hazard, Exposures, Exposure pathways, dose unit, measurement, and radiation protection. CRP and other guidance document etc. Radioactive Waste Management: Waste categorization, Generation, Handling of wastes, Liquid, gaseous and solid, Short term / long term storage / disposed.

**Reactor Stages and Safety Assurances-** Nuclear safety assurance.

[T1, T2, R1, R2][No. of Hrs. 11]

**Text Books:**

[T1] P.K. Nag. Nuclear Power Plant, Power Plant Engg. (Steam & Nuclear)

[T2] A.K. Raja, A.P. Srivastava & M. Dwivedi, An Introduction on Nuclear Engineering,

**Reference Books:**

[R1] Glasstone & Sesons- Nuclear Engineering

[R2] Arora & Domkundwar, A course in Power Plant Engg-

## ROBOTICS

**Paper Code: ETMT-402**

**Paper: Robotics**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To introduce the foundations of robotics. Also, a course on Robotics must use one or more software to not only visualize the motion and characteristics of robots but also to analyze/synthesize/design robots for a given application.*

### UNIT - I

**Fundamentals of Robot Technology:**

Robot definition, automation and robotics, Robot anatomy, Work volume, Drive systems. Control systems and dynamic performance. Accuracy and repeatability. Sensors and actuators used in robotics. Machine Vision, Robot configurations, Path control. Introduction to robot languages. Applications; Types (Mobile, Parallel); Serial: Cartesian, Cylindrical, etc.; Social Issues

[T1,T2,T3][No. of Hrs: 11]

### UNIT - II

**Robot Kinematics:** Mapping, Homogeneous transformations, Rotation matrix, Forward Kinematics (DH Notation) and inverse kinematics: Closed form solution.

**Robot Differential Motion:** Linear and Angular velocity of rigid link, Velocity along link, Manipulator jacobian, Statics: Use of jacobian.

[T1,T2,T3][No. of Hrs: 11]

### UNIT – III

**Robot Dynamics:** Lagrangian Mechanics, Lagrangian Formulation and numericals. Dynamics, Newton-Euler Recursive Algorithm, Simulation. Euler-Lagrange Equations of motion/Any one other formulation like using Decoupled Natural Orthogonal Complements (DeNOC)

**End effectors:** Mechanical and other types of grippers. Tools as end effectors. Robot and effector interface. Gripper selection and design.

[T1,T2,T3][No. of Hrs: 12]

### UNIT - IV

**Applications for Manufacturing.** Flexible automation. Robot cell layouts. Machine interference. Other considerations in work cell design. Work cell control, interlocks. Robot cycle time analysis. Mechanical design of robot links.

Typical applications of robots in material transfer, machine loading/unloading; processing operations; assembly and inspection.

[T1,T2,T3][No. of Hrs: 10]

**Text Books:**

- [T1] R.K. Mittal, I.J. Nagrath, "Robotics & Control", Tata McGraw & Hills, 2005.  
 [T2] Mikell P Groover, Mitchell Weiss "Industrial Robotics :Technology, Programming and Application" Tata McGraw & Hills, 2009.  
 [T3] Saha, S.K., Introduction to Robotics, 2<sup>nd</sup> Edition, McGraw-Hill Education, New Delhi, 2014

**Reference Books:**

- [R1] John J.Craig; "Introduction to Robotics Mechanics & Control", Pearson Education, 2004.  
 [R2] Robert J. Schilling, "Fundamentals of Robotics, analysis & Control", Prentice Hall (I) P. Ltd., 2002  
 [R3] Mark W. Spong, Seth Hutchinson, M. Vidyasagar "Robot Modeling and Control" John Wiley 2<sup>nd</sup> Ed  
 [R4] J Srinivasan, R.V.Dukkipati, K. Ramji, "Robotics control & programming", Narosa.  
 [R5] Ghosal, Ashitava, "Robotics: Fundamental Concepts and Analysis," Oxford University Press, 2006  
 [R6] M. Murray, M., Li, Zexiang, Sastry, S.S., "A Mathematical Introduction to Robotic Manipulation," CRC Press, 1994  
 [R7] Tsai, L.W., "Robot Analysis: The Mechanics of Serial & Parallel Manipulators," Wiley 1999  
 [R8] Niku, S. B., "Introduction to Robotics: Analysis, Systems, Applications", Prentice Hall, 2001



**RAPID PROTOTYPING**

**Paper Code: ETME-412**  
**Paper: Rapid Prototyping**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To introduce the students about the knowledge of liquid, solid and powder based rapid prototyping systems.*

**UNIT I****Introduction**

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications – Digital prototyping – Virtual Prototyping.

**Liquid Based and Solid Based Rapid Prototyping Systems**

Stereo lithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

[T1][T2][T3][No. of Hrs: 12]

**UNIT II****Powder Based Rapid Prototyping Systems**

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

[T1][T2][T3][No. of Hrs: 10]

**UNIT III****Reverse Engineering and Cad Modeling**

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

[T1][T2][T3][No. of Hrs: 12]

**UNIT IV****Rapid Tooling**

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries.

[T1][T2][T3][No. of Hrs: 10]

**Text Books:**

- |      |  |                              |
|------|--|------------------------------|
| [T1] | Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003 |                              |
| [T2] | Rapid Tooling: Technologies and Industrial Applications, Peter F.Jacobs, CRC press, 2000.  | D.Hilton,Hilton/Jacobs, Paul |
| [T3] | Serope kalpakjian , “Manufacturing Engg and Tech”; 4th edition,  | Pearson education            |

**References Books:**

- |      |   |
|------|---|
| [R1] | Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003   |
| [R2] | Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W.Liou, Frank W.Liou, CRC Press, 2007. |
| [R3] | Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer  |

**MECHANICAL VIBRATIONS**

**Paper Code: ETME-416**  
**Paper: Mechanical Vibrations**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:**

**MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from question no. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objectives: The objectives of this subject is to acquire the ability of students to formulate mathematical models of problems in vibrations and also determine a complete solution to mechanical vibration problems using mathematical or numerical techniques, and determine physical and design interpretations from the results.*

**UNIT-I**

**Systems with single degree of freedom-** Harmonic and periodic motions, vibration terminology, undamped free Vibrations, Energy method and Rayleigh's method, Logarithmic decrement, Experimental determination of damping coefficient, Damped free vibrations with viscous damping, forced vibrations with harmonic excitation, Magnification factor, Transmissibility, Rotor unbalance, Base excitation.

[T1, T2] [No. of Hrs. 11]

**UNIT – II**

Vibration isolation, Equivalent viscous damping, structural damping. Vibration measuring instruments. Whirling of rotating shafts with damping.

[T1, T2][No. of Hrs. 10]

**UNIT - III**

**Systems with two degrees of freedom-** Generalized and Principal coordinates derivation of equations of motion, Lagrange's equation, undamped free vibrations, normal modes, steady state undamped and damped forced vibrations.

[T1, T2][No. of Hrs. 10]

**UNIT – IV**

**Systems with multi-degree of freedom:**

Derivation of equations of motion, Influence co-efficient and generalized co-ordinates, Principal co-ordinates and orthogonality, Modal analysis: undamped and damped.

[T1, T2][No. of Hrs. 11]

**Text Book:**

- [T1] Singiresu S. Rao "Mechanical Vibrations" Pearson Education  
[T2] G.K. Grover, Mechanical Vibration, Nem Chand and Bross, Roorkee

**Reference Book:**

- [R1] W.T Thomson, "Theory of vibration" Prentice Hall of India Pvt. Ltd.  
[R2] N.S.V. Kameswara Rao, "Mechanical Vibrations of Elastic Systems", Asian Books Private Limited  
[R3] J.S. Rao and K. Gupta, "Vibration Engg", New Age Publications.



**SOFT COMPUTING****Paper Code: ETIT-410****Paper: Soft Computing**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To understand the various concepts of neural networks and fuzzy logic.*

**UNIT-I****Neural Networks:**

History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

**[T1, T2][No. of Hrs. 11]****UNIT-II****Fuzzy Logic:**

Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation, Operations.

**[T1, T2][No. of Hrs. 11]****UNIT-III****Fuzzy Arithmetic:**

Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic:

Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers,

**Uncertainty based Information:**

Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets.

**[T1, T2][No. of Hrs. 11]****UNIT-IV****Introduction of Neuro-Fuzzy Systems:**

Architecture of Neuro Fuzzy Networks.

**Application of Fuzzy Logic:**

Medicine, Economics etc.

**Genetic Algorithm:**

An Overview, GA in problem solving, Implementation of GA.

**[T1, T2][No of Hrs 11]****Text Books:**

- [T1] Hertz J. Krogh, R.G. Palmer, "Introduction to the Theory of Neural Computation", Addison-Wesley, California, 1991.
- [T2] G.J. Klir & B. Yuan, "Fuzzy Sets & Fuzzy Logic", PHI, 1995.
- [T3] Melanie Mitchell, "An Introduction to Genetic Algorithm", PHI, 1998.
- [T4] F. O. Karray and C. de Silva, "Soft computing and Intelligent System Design", Pearson, 2009.

**Reference Books:**

- [R1] "Neural Networks-A Comprehensive Foundations", Prentice-Hall International, New Jersey, 1999.
- [R2] Freeman J.A. & D.M. Skapura, "Neural Networks: Algorithms, Applications and Programming Techniques", Addison Wesley, Reading, Mass, (1992).

**DATA COMMUNICATION & NETWORKS****Paper Code: ETEC-420****Paper: Data Communication & Networks**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks.

*Objectives: The objective of the paper is to provide an introduction to the fundamental concepts on data communication and the design, deployment, and management of computer networks.*

**UNIT- I**

**Data Communications :** Components, protocols and standards, Network and Protocol Architecture, Reference Model ISO-OSI, TCP/IP-Overview, topology, transmission mode, digital signals, digital to digital encoding, digital data transmission, DTE-DCE interface, interface standards, modems, cable modem, transmission media-guided and unguided, transmission impairment, Performance, wavelength and Shannon capacity. Review of Error Detection and Correction codes.

**Switching:** Circuit switching (space-division, time division and space-time division), packet switching (virtual circuit and Datagram approach), message switching.

**[T1, T2, R1, R4] [No. of Hours: 11]****UNIT- II**

**Data Link Layer:** Design issues, Data Link Control and Protocols: Flow and Error Control, Stop-and-wait ARQ, Sliding window protocol, Go-Back-N ARQ, Selective Repeat ARQ, HDLC, Point-to-Point Access: PPP Point-to-Point Protocol, PPP Stack,

**Medium Access Sub layer:** Channel allocation problem, Controlled Access, Channelization, multiple access protocols, IEEE standard 802.3 & 802.11 for LANS and WLAN, high-speed LANs, Token ring, Token Bus, FDDI based LAN, Network Devices-repeaters, hubs, switches bridges.

**[T1, T2,R1][No. of Hours: 11]****UNIT- III**

**Network Layer:** Design issues, Routing algorithms, Congestion control algorithms, Host to Host Delivery: Internetworking, addressing and routing, IP addressing (class full & Classless), Subnet, Network Layer Protocols: ARP, IPV4, ICMP, IPV6 and ICMPV6.

**[T1, T2,R1][No. of Hours: 11]****UNIT- IV**

**Transport Layer:** Process to Process Delivery: UDP; TCP, congestion control and Quality of service.

**Application Layer:** Client Server Model, Socket Interface, Domain Name System (DNS): Electronic Mail (SMTP), file transfer (FTP), HTTP and WWW.

**[T2, T1, R1, R4][No. of Hours: 11]****Text Books:**

- [T1] A. S. Tannenbum, D. Wetherall, "Computer Networks", Prentice Hall, Pearson, 5<sup>th</sup> Ed  
 [T2] Behrouz A. Forouzan, "Data Communications and Networking", Tata McGraw-Hill, 4<sup>th</sup> Ed

**Reference Books:**

- [R1] Fred Halsall, "Computer Networks", Addison – Wesley Pub. Co. 1996.  
 [R2] Larry L, Peterson and Bruce S. Davie, "Computer Networks: A system Approach", Elsevier, 4<sup>th</sup> Ed  
 [R3] Tomasi, "Introduction To Data Communications & Networking", Pearson 7<sup>th</sup> impression 2011  
 [R4] William Stallings, "Data and Computer Communications", Prentice Hall, Imprint of Pearson, 9<sup>th</sup> Ed.  
 [R5] Zheng, "Network for Computer Scientists & Engineers", Oxford University Press  
 [R6] Data Communications and Networking: White, Cengage Learning

**GAS DYNAMICS****Paper Code: ETME-422****Paper: Gas Dynamics**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks.

*Objective: The objective of this paper is to introduce the students about the knowledge of basic concepts and isentropic flows of energy in gas dynamics.*

**UNIT- I****Basic Concepts and Isentropic Flows:**

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers – Use of Gas tables.

**[T1, T2, R1][No. of Hrs. 10]****UNIT- II****Flow through Ducts:**

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) variation of flow properties – Use of tables and charts – Generalized gas dynamics.

**[T1, T2, R1][No. of Hrs. 10]****UNIT- III****Normal and Oblique Shocks:**

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Use of table and charts – Applications. Other shocks -Detached Shocks-Shock Reflections-Numerical Examples-Shock-Shock Interactions Shock Expansion Theory-Theory, Examples and its Applications.

**[T1, T2, R1, R2][No. of Hrs. 12]****UNIT- IV****Nozzle Flow:**

Quasi-1D flow with area variations - Geometric Choking-Numerical Examples-Divergent Nozzles Convergent - Divergent-Nozzles-Numerical Examples- Multiple Choking points .Non-isentropic flows- Crocco's Theorem-Fanno Flow-Numerical Examples-Rayleigh Flow. Numerical Examples- Various Choking mechanisms, Ramjets and scramjets.

**[T1, T2, R1][No. of Hrs. 12]****Text Books:**

- [T1] James John and Theo Keith, "Gas Dynamics", Pearson, New Delhi  
 [T2] B.L Singhal, "Gas Dynamics and Jet Propulsion", Macmillan Publishers India Ltd, New Delhi

**Reference :**

- [R1] Zucker R. D. and Biblarz Oscar, "Introduction to Gas Dynamics", John Wiley and Sons. Inc., Second Edition [2002]  
 [R2] A. H. Shapiro, "Dynamics and Thermodynamics of Compressible Fluid Flow", MIT Press.

**CRYOGENIC ENGINEERING****Paper Code: ETME-424****Paper: Cryogenic Engineering**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks.

*Objective: To introduce the students about the knowledge of principles of refrigeration and liquefaction, gas liquefaction systems and cryogenic equipment.*

**UNIT-I**

**Refrigeration And Liquefaction Principles:** Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison. Properties of cryogenic fluids; Properties of solids at cryogenic temperatures, Superconductivity. Adiabatic Expansion - Liquefaction Systems for Air, Neon, Hydrogen and Helium - Effect of component efficiencies on System Performance.

**[T1, T2, R1, R2][No. of Hrs.11]****UNIT-II**

**Gas Liquefaction Systems:** Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovaý refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas.

**Cryogenic insulation:** Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

**[T1, T2, R2][No. of Hrs.12]****UNIT-III**

**Storage Of Cryogenic Liquids:** Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems.

**Cryogenic instrumentation:** Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

**[T1, T2, R1, R2][No. of Hrs.11]****UNIT-IV**

**Cryogenic equipment:** Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization. Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryopumping Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport.

**[T1, T2, R1,][No. of Hrs.11]****Text Books:**

[T1] Randall Baron, Cryogenic System, Mc Graw Hill

[T2] K.D. Timmerhaus &amp; T.M. Flynn, Cryogenic Process Engineering, Plenum Press

**Reference Books:**

[R1] Russel B Scott, Cryogenic Engineering, Van Nostrand

[R2] R W Yance and WM Duke, Applied Cryogenic Engineering, John Willey.

**TOTAL QUALITY MANAGEMENT****Paper Code: ETME-426****Paper: Total Quality Management**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks.

*Objective: To introduce the students about the knowledge of quality management, Cost quality and six-sigma concepts.*

**UNIT-I**

**Introduction** - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

**[T1,T2][No. of Hrs. 10]****UNIT-II**

**Leadership** – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

**[T1,T2][No. of Hrs. 11]****UNIT-III**

**The seven traditional tools of quality** – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

**[T1,T2][No. of Hrs. 12]****UNIT-IV**

**Need for ISO 9000- ISO 9000-2000 Quality System** – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

**[T1,T2][No. of Hrs. 10]****Text Books:**

- [T1] Janakiraman, B and Gopal, R.K, “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd., 2006.
- [T2] Dale H.Besterfield, et al., “Total Quality Management”, Pearson Education Asia

**Reference Books:**

- [R1] James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
- [R2] Oakland, J.S., “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition,
- [R3] Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd.,2006

**SUPPLY CHAIN MANAGEMENT-PLANNING****Paper Code: ETTTE-424****Paper: Supply Chain Management-Planning**

<b>L</b>	<b>T/P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>3</b>

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be 12.5 marks.

*Objectives: The objective of the course is to provide a comprehensive analysis of the principles and practices of supply chain management. It will help the student to understand the activities of SCM and provide grounding in this field.*

**UNIT-I**

Supply Chain Management - Concepts, Issues in Supply Chain Management; Demand Volatility and information distortion, Managing networks and relationships; Sourcing Internationally, Subcontracting within an International Dimension, The Architecture of Physical distribution network : Distribution Management: Types of Intermediaries, Channel Objectives and Constraints, Channel Selection and Management, Global Retailing, International Channel Innovation.

**[T1, T2][No. of Hrs. 10]****UNIT-II**

Logistics Framework – Concept, Objective and Scope; Transportation, Warehousing, Inventory Management; Packing and Unitization; Control and Communication, Role of Information Technology in Logistics, Logistics Service Firms and Third Party Logistics.

**[T1, T2][No. of Hrs. 10]****UNIT-III**

Logistics Network Design for Domestic/Global Operations: Logistics Network Configuration, Orienting International Facilities: Considerations and Framework, Trade-offs Associated with each Approach, Mapping the different Approaches, Capacity Expansion Issues; Information Management for Global Logistics: The Global LIS/LITS: Capabilities and Limitations, Characteristics of Logistics Information and Telecommunications Systems.

**[T1, T2][No. of Hrs. 12]****UNIT-IV**

Performance Measurement and Evaluation in Global Logistics: Operations and Logistics Control: Key Activities Performance Information, Measuring Performance in Functional Integration, Measuring Performance in Sectoral Integration; Measurements and improvements of SCM service quality and performance; Past, present and future of Supply Chain Management.

**[T1, T2][No. of Hrs. 10]****Text Books**

- [T1] Christopher Martin. (2005). Logistics & Supply Chain Management Creating Value-adding Networks, 3rd Edition, Pearson Education..
- [T2] S.K. Bhattacharyya (2010) Logistics Management, Definition, Dimensions and Functional Applications, S. Chand and Company, Delhi.

**Reference Books:**

- [R1] Chopra Sunil and Peter Meindl (2009). Supply Chain Management, 4th Edition, Pearson Education.
- [R2] Ballou, R. H. (2004). Business Logistic Management, 5th Edition, Prentice Hall, New Delhi.
- [R3] Bowersox, D. J., David, J & Cooper (2002). Supply Chain Logistics Management, McGraw Hill.



**TURBO MACHINERY**

**Paper Code: ETME-432**  
**Paper: Turbo Machinery**

L	T/P	C
3	0	3

**INSTRUCTIONS TO PAPER SETTERS:****MAXIMUM MARKS: 75**

1. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. It should be of 25 marks.
2. Apart from Question No. 1, rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, student may be asked to attempt only 1 question from each unit. Each question should be of 12.5 marks.

*Objective: To introduce the students about the knowledge of steam turbine, gas turbines, jet propulsion, rotary compressor and hydraulic turbines.*

**UNIT I**

**Steam Turbines**-Types of turbines, constructional details, application of turbines, types of seal, packing to reduce leakage, losses in turbines. Compounding of turbine, velocity diagrams, output efficiency, losses in turbines, reaction turbine, velocity, diagrams, degree of reaction, constructional features of blades. Governing of turbines.

**[T1, T2][No. of Hrs. 10]****UNIT II**

**Gas Turbine**-Theory and fundamentals of gas turbines, principles, classification, Joule's cycles, assumptions for simple gas turbines, cycle analysis, work ratio, concept of maximum and optimum pressure ratio, actual cycle, effect of operating variable on thermal efficiency. Regeneration, inter cooling, reheating, their effects on performance. Closed cycle and semi closed cycles gas turbine plant/ Applications of gas turbines.

**[T1, T2][No. of Hrs. 10]****UNIT III**

**Jet Propulsion**-Introduction, types of jet engines, application of jet engines. Theory of jet propulsion, energy flow through jet engines, thrust, thrust power, propulsive efficiency. Turbo jet, turbo prop, turbo fan engines, pulse jet and ram jet engines, performance characteristics thrust segmentation. Concept of rocket propulsion.

**Rotary Compressor**-Concept of: Rotary compressors, Root blower and vane type compressors, Centrifugal compressors. Velocity diagram construction and expression for work done, introduction to slip factor, power input factor.

**[T1, T2][No. of Hrs. 12]****UNIT IV**

**Hydraulic Turbines**-Classification of hydraulic turbines, Heads & various efficiencies. Impulse momentum principle, Fixed and moving flat plate and curve vanes, series of plates & vanes. Velocity triangles and their analysis, work done, efficiency etc. Impulse turbine: Main components and constructional features of pelton wheel, velocity diagrams & work done, condition for max. Hydraulic Efficiency, number of buckets, jets Non dimensional parameters (speed ratio, jet ratio). Governing mechanisms for pelton wheel. Reaction turbine, main components & constructional features, types of reaction turbine (Francis, Kaplan), draft tube types, efficiency, cavitation, Francis, Kaplan turbines, Types of characteristic curves, unit quantities, selection of turbine considering various factors, specific speed, Application of similarity as applied to turbines, scale effect.

**[T1, T2][No. of Hrs. 12]****Text Books:**

- [T1] Yahya, S.M., "Turbines compressors and fans": Tata McGraw-Hill.  
 [T2] Gorla, R.S.R, & Khan, A.A. "Turbo Machinery: Design and Theory": Marcel Dekker, Inc.

**Reference Books:**

- [R1] Dixon, S.L., "Fluid mechanics and thermodynamics of turbo machinery": Butterworth-Heinemann.  
 [R2] Peng, W. W., "Fundamentals of Turbo Machinery": J. Wiley  
 [R3] Baskharone, E.A., "Principles of Turbo Machinery in air-breathing engines": Cambridge University Press.

**ENGINEERING SYSTEM MODELLING AND SIMULATION LAB**

<b>Paper Code: ETME-452</b>	<b>L</b>	<b>T/P</b>	<b>C</b>
<b>Paper: Engineering System Modeling and Simulation Lab</b>	<b>0</b>	<b>2</b>	<b>1</b>

**List of Experiments:**

**A. Mechanical Event Simulation:**

The students are exposed to simulating in CAD software in this lab ( software can be choice of institute – such as PROE - wildfire 5 / PROE -CREO / NX / Solid Edge / solid works / Catia / any other.

1. Study assembly module on CAD software;
2. Simulate movement of cam and follower mechanism on CAD software.
3. Simulation of Spring Mass Damper System and do dynamic analysis on CAD software.
4. Perform FEM Analysis (using a simple 3D tetrahedron element) on a Simple model with pressure loading and surface constraints;
5. Perform stress analysis of rectangular L bracket using Pro E / any other software and do global sensitivity analysis.

**B. System Simulation:**

The students are exposed to simulation software like Arena / any other.

1. Study modeling environment;
2. Study basic process panel;
3. Study basic process panel - more;
4. Study advanced process panel;
5. Study advanced process panel - more;
6. Study flow process panel;
7. Study flow process panel- more;

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**



**STATISTICAL QUALITY CONTROL AND RELIABILITY LAB****Paper Code: ETME-454****L T/P C****Paper: Statistical Quality Control and Reliability Lab****0 2 1****List of Experiments:**

1. To verify the various statistical relationships from the results of observations of 200 drawings from the Shewhart's Normal Bowl containing 998 chips and to fit a normal curve by making a histogram from the individual observations. Take a subgroup of 5. The given statistical relationships are:

$$\bar{X}' = \bar{\bar{X}} \quad \sigma' = \sigma_{\bar{X}} \sqrt{n} \quad \sigma' = \bar{R}/d_2 \quad \sigma' = \bar{\sigma} / c_2 \quad \sigma' = \sigma_{\sigma} / c_5$$

2. To plot and determine the given unknown distribution from the results of observations of 180 drawings from the given bowl containing 778 chips. Take a sample size of 4.
3. To determine the process capability of the manual sheet metal cutting process by cutting 80 rectangular pieces (length = 30 mm & breadth = 25 mm) from 28 gauge G. I. sheet. Take a subgroup size of 5.
4. To plot p and np charts from the observations of 20 samples of 100 each drawn from the population of 3000 balls containing 5% defective balls.
5. To plot the  $\bar{X}$ , R &  $\sigma$  control charts from the observations of 120 drawings from the Shewhart Normal Bowl containing 998 chips having population parameters as  $\bar{X}' = 30$  and  $\sigma' = 9.954$ , Take a subgroup size of 5.
6. To state and prove the Central Limit Theorem. Take 180 observations from the Shewhart's Normal Bowl and take a sample size of 4.
7. To design a 2% A.O.Q.L single sampling plan by inspecting a population of 3000 balls submitted in 10 lots of 300 balls each with a process average as 0.3% to 3.0% in steps of 0.3%.
8. To plot control chart for c from the observations of 24 sample items drawn from population of 110 items.
9. To design a sequential sampling plan in which the producer's risk of rejecting the lots containing 5% defectives is 4% and the consumer's risk of accepting the lots containing 30% defectives is 20%. Use the designed sampling plan to inspect a population having process average 6% to 30% in steps of 6%. The maximum number of pieces to be inspected is 24.

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**

**CRYOGENIC ENGINEERING****Paper Code: ETME-456 (ELECTIVE)****L T/P C****Paper: Cryogenic Engineering****0 2 1****List of Experiments:**

1. Visit to Nitrogen liquefaction plant.
2. Design of a recuperative cryogenic heat exchanger for a given liquefaction system.
3. Calibration of a cryogenic temperature-measuring instrument.
4. Trial / Design of Stirling cycle refrigerator.
5. Trial / Design of Pulse tube refrigerator.

**NOTE:- At least 8 Experiments from the syllabus must be done in the semester.**

**ROBOTICS LAB****Paper Code: ETME-456 (ELECTIVE)****L T/P C****Paper: Robotics Lab****0 2 1****List of Experiments:**

1. Study of robotic arm, end effectors and its configuration and introduction to any software (such as workspace) used to simulate or program a robot;
2. Program / simulate a robot for moving on a path;
3. Program / simulate a robot for pick and place operation;
4. Program / simulate a robot for welding operation;
5. Program / simulate a robot for water jet machining;
6. Program / simulate a robot for saving it from striking any other object in workspace;
7. Program / simulate two robots working together;
8. Make a 3R robot and simulate its motion.
9. Use a microcontroller to program simple toy robot / model robot;
10. Micro controller program to use different sensors and further move toy robot(s) / model robot;
11. Use MATLAB / Scilab. Any other software to program numericals (Robot Arm kinematics) taught in class.
12. Use MATLAB / Scilab and other robot specific software like Robo-Analizer for the study of kinematic and dynamics of 3R robots.
13. Demos of a real robot; Introduce Virtual Robotics Lab. in ADAMS or SimMechanics of MATLAB.

**Note:**

- a. Total Experiments are to be 12 (Twelve).
- b. Experiments suggested by committee are given above- Choose any eight.
- c. Rest (In above list / not in list) is liberty of respective institute to choose as per syllabus.
- d. Suggested Software

A course on Robotics must use one or more software to not only visualize the motion and characteristics of robots but also to analyze/synthesize/design robots for a given application (say, as class projects). Typical software which can be used are as follows:

- RoboAnalyzer (Developed by IIT Delhi; <http://www.roboanalyzer.com>)
  - Virtual Labs. (Developed by IIT Kharagpur; <http://vlabs.iitkgp.ernet.in/moodle/>)
  - MATLAB, its modules Simulink and SimMechanics (<http://www.mathworks.com>)
  - Mathematica: Symbolic software (<http://www.wolfram.com>)
  - Multi Bondgraph (<http://bondgraph.org>)
  - ADAMS (by MSC software; <http://www.mscsoftware.com>)
  - RerurDyn (by Function Bay, Korea; <http://www.functionbay.co.kr>)
- e. **Other Aids**
- **Possible Class projects and presentations:** Kinematic/Dynamic modeling, programming, and analyses of a robotic arm (say, an RP manipulator); 2. Modeling of an AGV; 3. Building prototypes using, say, LEGO kits
  - Video of practical applications
  - Industry visits
  - Robocon competitions: A national-level competition held every year during the 1<sup>st</sup> weekend of March

**NOTE:- At least 8 Experiments out of the list must be done in the semester.**