

(Established under Gujarat Private Universities Act, 2009)

## Shroff S.R. Rotary Institute of Chemical Technology

Ref: UPL University /SRICT/BOS/ME/2021-22/01

Date: 12-03-2022

### Proposed Teaching Scheme for Second Year Bachelor of Mechanical Engineering

#### Semester-III (Mechanical Engineering) Proposed Structure

Sl. No	Category of Course	Code No.	Course Title	Hours per week			Total contact hrs/ week	Total Credits	E	M	I	V	Total Marks
				L	T	P							
1	Humanities & Social Science	MH2201	Communication skills in English	2	0	2	4	3	70	30	20	30	150
2	Basic Science	HH2202	Mathematics-III	3	2	0	5	5	70	30	0	50	150
3	Engineering Science	ME2201	Engineering Mechanics	3	1	0	4	4	70	30	20	30	150
4	Professional Core Course	ME2202	Engineering Thermodynamics	4	0	0	4	4	70	30	0	0	100
5	Professional Core Course	ME2203	Material Science & Metallurgy	3	0	2	5	4	70	30	20	30	150
6	Professional Core Course	ME2204	Kinematics & Theory of Machines	4	1	0	5	5	70	30	20	30	150
7	Project/ Seminar/ Ind. Training/ Mandatory Course	ME2205	Inplant Training	0	0	0	0	1	0	0	50	0	50
<b>Total</b>				19	4	4	27	26	420	180	150	150	900

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**Semester-IV (Mechanical Engineering) Proposed Structure**

Sl. No	Category of Course	Code No.	Course Title	Hours per week			Total contact hrs/ week	Total Credits	E	M	I	V	Total Marks
				L	T	P							
1	Humanities & Social Science	MH2204	Universal Human Values	3	0	0	3	3	70	30	0	0	100
2	Basic Science	ME2205	Operation Research	3	0	0	3	3	70	30	0	0	100
3	Professional Core Course	ME2206	Strength of Materials	3	0	2	5	4	70	30	20	30	150
4	Professional Core Course	ME2207	Fluid Mechanics & Fluid Machines	3	0	2	5	4	70	30	20	30	150
5	Professional Core Course	ME2208	Manufacturing Processes	3	0	2	5	4	70	30	20	30	150
6	Professional Core Course	ME2209	Mechanical Measurement & Metrology	3	0	2	5	4	70	30	20	30	150
7	Professional Elective Course-I	ME2210/11/12	* Any one Professional Elective	2	0	0	2	2	70	30	0	0	100
<b>Total</b>				20	0	8	28	24	490	210	80	120	900

7	Professional Elective Course-I	ME2210	Oil Hydraulics and Pneumatics	2	0	0	2	2	70	30	0	0	100
7	Professional Elective Course-I	ME2211	Lubrication Technology	2	0	0	2	2	70	30	0	0	100
7	Professional Elective Course-I	ME2212	Control System	2	0	0	2	2	70	30	0	0	100



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**A. Course code and definition:**

<b>Course code</b>	<b>Definitions</b>
L	Lecture
T	Tutorial
P	Practical
E	Theory External Examination Marks
M	Theory Internal Examination Marks
I	Practical Internal Examination Marks
V	Practical External Examination Marks

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**Bachelor of Engineering**  
**Subject Code: MH2201**  
**Subject Name: Communication Skills in English**

## Shroff S.R. Rotary Institute of Chemical Technology

**Semester: - III**

**Type of course: Language and Communication**

**Prerequisite:** Zeal to learn the Language

**Rationale:** The rationale of the curriculum is to help students to express their original ideas in English and also develop interest in language and literature with a focus on comprehension, and reading, speaking and writing skills

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	Dynamics of Communication: Definition and process Kinesics Proxemics Paralinguistic features Importance of Interpersonal and Intercultural Communication in today's organizations	6
2	Technical Writing: Report writing Technical proposal Technical description Business letters(sales, order, complaint, adjustment, inquiry, recommendation, appreciation, apology, acknowledgement, cover letter) Agenda of meeting, Minutes of meeting Resume writing	7
3	Technical Communication: Public speaking, Group discussion, Presentation strategies, Interview skills, Negotiation skills ,Critical and Creative thinking in communication	7
<b>SECTION-B</b>		
4	Ethics in Engineering: Scope of engineering ethics, Accepting and sharing responsibility , Resolving ethical dilemmas, Making moral choices	6

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**Bachelor of Engineering**  
**Subject Code: MH2201**  
**Subject Name: Communication Skills in English**

<b>5</b>	Etiquettes: Telephone etiquettes for foreign business trips, Etiquettes for small talks, Respecting privacy ,Learning to say NO, Time management, Scope of engineering ethics, Accepting and sharing responsibility ,Resolving ethical dilemmas ,Making moral choices	<b>7</b>
<b>6</b>	Self-development and Assessment: Change, Grow, Persist, Prioritize, Read, Learn, Listen, Record, Remember, Asses, Think, Communicate, Relate, Dream.	<b>6</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
15	15	15	15	5	5

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Language Laboratory Activities:**

<b>Sr. no</b>	<b>Practical/ Exercise</b>	<b>Apprx. Hours required</b>
1	Role Play	02
2	Letter writing: Formal	02
3	Group Discussion	02
4	Presentations	02
5	Book Review(Preferably related to self-development)	04
6	Mock Interview	02
7	Report writing	02
8	Case studies related to unit 4, 5 and 6	02
9	Conducting meeting with Agenda	02
10	Minutes of Meeting	02

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**Bachelor of Engineering**  
**Subject Code: MH2201**  
**Subject Name: Communication Skills in English**

**Reference Books:**

1. Raman and Sharma, Technical Communications, OUP, New Delhi, 2017
2. Lata and Kumar, Communication Skills, OUP, New Delhi, 2018
3. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw Hill, New York, 2014
4. Mohapatra and Sreejesh S., Case Studies in Business Ethics and Corporate Governance, Pearson, UP, 2013
5. Ramesh and Ramesh, The Ace of Soft Skills, Pearson, UP, 2019
6. Sherfield, Montgomery and Moody, Cornerstone: Developing Soft Skills, UP, 2009
7. Open Sources: <https://www.scu.edu/ethics/focus-areas/more/engineering-ethics/engineering-ethics-cases>

**Course Outcomes:** After Learning this course, students will be able to:

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Define and describe dynamics of verbal and non-verbal aspects of communication.
CO-2	Associate with various formal documents of technical and professional communication
CO-3	Interpret communication of diverse formal situations taking place in organizations.
CO-4	Illustrate and examine the knowledge of ethical aspects of engineering
CO-5	Establish and explain social and professional etiquettes.
CO-6	Recommend self -development and self - assessment.

**List of Open Source Software/learning website:**

Open Sources: <https://www.scu.edu/ethics/focus-areas/more/engineering-ethics/engineering-ethics-cases>

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**Bachelor of Engineering**  
**Subject Code: MH2201**  
**Subject Name: Engineering Mechanics**

## Shroff S.R. Rotary Institute of Chemical Technology

**Semester: 3<sup>rd</sup>**

**Type of course:** Engineering Science Course

**Prerequisite:** Zeal to learn the subject

**Rationale:** The objective of this Course is to provide an introductory treatment of Engineering Mechanics to all the students of engineering, with a view to prepare a good foundation for taking up advanced courses in the area in the subsequent semesters. A working knowledge of statics with emphasis on force equilibrium and free body diagrams. Provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behaviour of materials under various load conditions. Lab should be taken concurrently

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	-	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Introduction to Engineering Mechanics:</b> Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant-Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy	7
2	<b>Friction:</b> Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack	4
3	<b>Basic Structural Analysis/Truss:</b> Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines.	7

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**Bachelor of Engineering**  
**Subject Code: MH2201**  
**Subject Name: Engineering Mechanics**

SECTION-B		
<b>4</b>	<b>Centroid and Centre of Gravity:</b> Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.	<b>7</b>
<b>5</b>	<b>Introduction to Kinetics of Rigid Bodies:</b> Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation	<b>7</b>
<b>6</b>	<b>Mechanical Vibrations:</b> Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound pendulums	<b>4</b>

**Suggested Specification table with Marks (Theory):**

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
<b>5%</b>	<b>20%</b>	<b>25%</b>	<b>25%</b>	<b>25%</b>	<b>0%</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Reference Books:**

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, - Dynamics, 9th Ed, Tata McGraw Hill.
3. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education
7. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics

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**Bachelor of Engineering**  
**Subject Code: MH2201**  
**Subject Name: Engineering Mechanics**

8. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

**List of Practical:**

1. Determine resultant of parallel force system graphically.
2. Determine and derive Law of Polygon of Forces.
3. Determine resultant of member is in tension or compression Simple Trusses.
4. Verify Lami's theorem.
5. Determine support reactions for simply supported beam.
6. Derive Law of machine using Worm and worm wheel.
7. Efficiency of Machine & Law of Machine.
8. Determine coefficient of friction for motion on horizontal and inclined plane.
9. Determine centroid of geometrical plane.
10. Determine the Moment of Inertia of geometric plane.

**Course Outcomes:**

Sr. No.	CO statement
CO-1	Solve the system of forces in equilibrium
CO-2	Apply concept of free-body diagrams of different arrangements.
CO-3	Analyse the structural problem of Truss
CO-4	Calculate the centroid and moment of inertia of a plane area
CO-5	Understand the concepts of rigid bodies.
CO-6	Understanding the basics of Vibration.

**List of Open Source Software/learning website:**

<https://nptel.ac.in>

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**Bachelor of Engineering**

**Subject Code: ME2202**

**Subject Name: Engineering Thermodynamics**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: - III**

**Type of course:** Professional Core Course

**Prerequisite:** Zeal to learn the subject

**Rationale:** To provide a fundamental knowledge of Engineering Thermodynamics for the students of Mechanical Engineering branch.

**Teaching and Examination Scheme:**

Teaching Scheme			C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)		
4	0	0	4	70	30	00	00	100

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Basic Concepts Of Thermodynamics:</b> Introduction. Classical and Statistical thermodynamic. System, surroundings, system boundary, control mass and control volume. Thermodynamic properties, processes and cycles, quasi-static process, Pure substance, continuum concept. Working substance. Phase used in thermodynamics, Representation of thermodynamic processes and cycles on 2-property plots. Temperature and Zeroth law of thermodynamics, Concept of heat and work	04
2	<b>First law of Thermodynamics:</b> First law for a closed system undergoing a cycle and change of state, energy, PMM1, first law of thermodynamics for steady flow process, steady flow energy equation applied to nozzle, diffuser, boiler, turbine, compressor, pump, heat exchanger and throttling process, filling and emptying process <b>Second law of thermodynamics:</b> Limitations of first law of thermodynamics, Kelvin-Planck and Clausius statements and their equivalence, PMM2, causes of irreversibility, Carnot theorem, corollary of Carnot theorem, thermodynamic temperature scale	12

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**Bachelor of Engineering**

**Subject Code: ME2202**

**Subject Name: Engineering Thermodynamics**

<b>3</b>	<p><b>Entropy:</b> Clausius theorem, property of entropy, inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, entropy change for non-flow and flow processes</p> <p><b>Exergy:</b> Exergy of a heat input in a cycle, exergy destruction in heat transfer process, exergy of finite heat capacity body, exergy of closed and steady flow system, irreversibility and Gouy-Stodola theorem and its applications, second law efficiency</p>	<b>08</b>
<b>SECTION-B</b>		
<b>4</b>	<p><b>Vapor Power cycles:</b> Carnot vapor cycle, Rankine cycle, comparison of Carnot and Rankine cycle, calculation of cycle efficiencies, variables affecting efficiency of Rankine cycle, reheat cycle, regenerative cycle, reheat-regenerative cycle, feed water heaters</p>	<b>08</b>
<b>5</b>	<p><b>Gas Power cycles:</b> Recapitulation of Carnot, Otto and Diesel cycle, Dual cycle, Comparison of Otto, Diesel and Dual cycles, air standard efficiency, mean effective pressure, brake thermal efficiency, relative efficiency, Simple Brayton cycle</p> <p><b>Refrigeration Cycles:</b> Simple Vapour Compression Refrigeration (VCR) cycle on P-h and T-s diagrams, analysis of the simple cycle, factors affecting the performance of the cycle, actual cycle, Reversed Carnot cycle and its limitation, Bell-Coleman cycle</p>	<b>12</b>
<b>6</b>	<p><b>Properties of gases and gas mixtures:</b> Avogadro's law, equation of state, ideal gas equation, Vander Waal's equation, reduced properties, law of corresponding states, compressibility chart. Gibbs-Dalton law, volumetric analysis of gas mixture, apparent molecular weight and gas constant, specific heat of a gas mixture, adiabatic mixing of perfect gases, gas and vapour mixtures.</p>	<b>04</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>20%</b>	<b>35%</b>	<b>30%</b>	<b>15%</b>	<b>NA</b>	<b>NA</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels**

**Textbooks:**

1. Engineering Thermodynamics by J.P.Hadiya and H.G. Katariya, Books India Publications.
2. Engineering Thermodynamics by P.K. Nag, McGraw-Hill Education.

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**Bachelor of Engineering**  
**Subject Code: ME2202**  
**Subject Name: Engineering Thermodynamics**

**Reference Books:**

1. Fundamentals of Engineering Thermodynamics by R.Yadav, Central Publishing House, Allahabad.
2. Engineering Thermodynamics by R.K. Rajput, Laxmi Publications, New Delhi.
3. Engineering Thermodynamics by Gordon Rogers and Yon Mayhew, Pearson Education Ltd.
4. Thermodynamics – An Engineering Approach by Yunus Centel & Boles, Tata McGraw-Hill, New Delhi.
5. Engineering Thermodynamics by Jones and Dugan, PHI Learning Pvt. Ltd.

**Course Outcomes:**

Students will be able to:

Sr. No.	CO statement
CO-1	<b>Enumerate</b> basic terms used in thermodynamics.
CO-2	<b>Describe</b> laws of thermodynamics and its applications.
CO-3	<b>Apply</b> the concepts and applications of entropy and exergy.
CO-4	<b>Analyze</b> Vapour power cycles for engineering applications.
CO-5	<b>Understand</b> and <b>analyze</b> the different thermodynamics cycles.
CO-6	<b>Explain</b> the properties of gases and gas mixtures.

**List of Open Source Software/learning website:**

<https://nptel.ac.in/course.php>  
[www.vlab.co.in](http://www.vlab.co.in)

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**Bachelor of Engineering**  
**Subject Code: ME2203**  
**Subject Name: Material Science & Metallurgy**

## Shroff S.R. Rotary Institute of Chemical Technology

### Semester: III

**Type of course: Professional Core Course**

**Prerequisite:** Zeal to learn the subject

**Rationale:** Basic principles of science are used to study the structure-properties relationships of various materials for their proper applications in this subject. Especially study of different types of ferrous and non-ferrous metals and alloys, in terms of their composition, structure, properties and applications; nondestructive testing are included in this course to understand the basic concept of selection and processing of metals and materials for their applications.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	Introduction to Material Science and Metallurgy: Basics of Engineering Materials, their Classifications and Application, Engineering requirements of materials, Properties of engineering materials, Criteria for selection of materials for engineering Applications.  Macro-examination, Spark Test, Sculptures Print, Macro-etching, Microscopic examinations.	5
2	Crystal Geometry and Crystal Imperfection: Unit Cell, Crystal structure, Bravais lattice, atomic packing, coordination number, crystal structures of metallic elements, crystal directions and planes, Miller indices, Polymorphism or Allotropy.	8

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**Bachelor of Engineering**

**Subject Code: ME2203**

**Subject Name: Material Science & Metallurgy**

	Crystallization: Mechanism of crystallization - nucleation and growth, factors influencing nucleation and growth. Imperfections in crystals and their effect on properties,	
<b>3</b>	<p>Solidification and Theory of Alloys: Solidification of metals and an alloy, Nucleation and Growth during freezing of pure metal and alloy ingot/a casting Resultant macrostructures; Effects of Structure on Mechanical Properties. Gibb's phase rule. Solid solutions and compounds, Hume-Rothery rules; Cooling curves, lever-arm principle.</p> <p>Phase and Phase equilibrium: Unary and Binary equilibrium phase diagrams, Different reactions like eutectic, eutectoid, peritectic and peritectoid.</p>	<b>8</b>
<b>SECTION-B</b>		
<b>4</b>	<p>Allotropy of Iron, Iron-Iron Carbide equilibrium system: Allotropy of iron; Iron-iron carbide equilibrium diagram: Phases present and their properties, different reactions of the Iron-Iron Carbide equilibrium system; constituents, microstructures and properties of plain carbon steels.</p> <p>Alloy groups (Wrought Irons, Steels and Cast Irons) of Iron-Iron Carbide equilibrium system and their characteristics in general.</p>	<b>7</b>
<b>5</b>	<p>TTT diagram and Heat Treatment of Steel: Time-Temperature-Transformation Diagram, Isothermal and continuous transformations. Study of heat treatment processes such as annealing, normalizing, spheroidizing, hardening, tempering, carburizing, nitriding, cyaniding, induction hardening, flame hardening and hardenability of steel.</p>	<b>6</b>
<b>6</b>	<p>Powder Metallurgy: Applications of powder metallurgy, advantages of powder metallurgy, manufacturing processes, production of powder, compacting, sintering, products of powder metallurgy.</p> <p>Non Destructive Testing: Non Destructive testing of materials such as Radiography Testing, Dye Penetration Testing, Magnetic Particle Testing, Ultrasonic Testing. Eddy current testing with their Principle of non-destructive testing, the test methods, relative merits, demerits and applications.</p>	<b>8</b>

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**Bachelor of Engineering**  
**Subject Code: ME2203**  
**Subject Name: Material Science & Metallurgy**

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
<b>10%</b>	<b>35%</b>	<b>30%</b>	<b>15%</b>	<b>10%</b>	<b>0%</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Text Books:**

1. O. P. Khanna, "A Textbook of Material Science and Metallurgy", Edition, 5, Dhanpat Rai, 1987.

**Reference Books:**

1. Donald R. Askeland and Pradeep P. Phule, "The Science and Engineering of Materials", Edition, 5, Cengage Learning, 2005.
2. William F. Smith, "Principles of Materials Science and Engineering", Edition, 4, McGraw Hill, 2020.
3. Lawrence H. Van Vlack, "Elements of Material Science and Engineering", Pearson Education.
4. Ed. George F. Vander Voort, "Metallography and Microstructure", ASM International 2004.
5. Baldev Raj, T. Jayakumar and M. Thavasimuthu, "Practical Non-Destructive Testing", Narosa Pub. House. ASM Handbook Vol.
6. K. I. Parashivamurthy, "Materials Science and Metallurgy", Pearson Education

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**Bachelor of Engineering**

**Subject Code: ME2203**

**Subject Name: Material Science & Metallurgy**

**List of Practical/ tutorials:**

1. To get acquainted with the operation, construction, use and capabilities of a metallographic microscope.
2. To study procedure of specimen preparation for microscopic examination and to carry out a specimen preparation.
3. To understand what is micro examination, importance of micro examination and to study various ferrous, non-ferrous microstructures.
4. To identify the different types of material available for design, manufacturing and processing of various components based on structure-property-performance-processing relationships.
5. To show the effect of different quenching media (Oil, Water and Brine) on the hardness of medium carbon steel.
6. To understand the Iron-Iron Carbide Equilibrium Diagram.
7. Study of different heat treatment processes- annealing, normalizing, hardening and tempering, surface and casehardening to improve properties of steel during processes and applications.
8. To understand the concept of hardenability and its relevance to heat treatment procedure to be adopted in practice.
9. To understand the principle & working of the liquid penetrant test and the magnetic particle test.
10. To understand the principle & working of the Eddy current test and the Ultrasound test.

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**Bachelor of Engineering**

**Subject Code: ME2203**

**Subject Name: Material Science & Metallurgy**

**Course Outcomes:**

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Understand the basic concept of Material Science and Metallurgy.
CO-2	Know about the ferrous and non-ferrous metals and alloys and their Applications.
CO-3	Describe various heat treatment processes for the different metals.
CO-4	Understand different non-destructive testing methods.
CO-5	Evaluate the processes of the powder metallurgy products.
CO-6	Judge the Scope and limitations of different materials.

**List of Open Source Software/learning website:**

[nptel.ac.in](http://nptel.ac.in)

[www.learnerstv.com](http://www.learnerstv.com)

[Cosmolearning.org](http://Cosmolearning.org)

<https://www.vlab.co.in/>

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**Bachelor of Engineering**

**Subject Code: ME2204**

**Subject Name: Kinematics and Theory of Machines**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: III**

**Type of course:** Programme Core Course

**Prerequisite:** Zeal to learn the subject

**Rationale:** Kinematics and theory of machines is a fundamental course for mechanical engineering. It is intended to introduce essential elements of machines and their functionality. This course is essential for synthesis and kinematics analysis of machine elements like linkages, cams, belt, rope, brakes and gear.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	1	0	5	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>Basics of Mechanisms:</b> Introduction, Mechanism and machine, Rigid and resistant body, Link, Kinematic pair, Types of motion, Degrees of freedom (mobility), Classification of kinematic pairs, Kinematic chain, Linkage, Mechanisms, Kinematic inversion, Inversions of slider crank chain, Synthesis of Mechanism, Double slider-crank chain, Quick return mechanism, Limiting Positions and Mechanical Advantage.	<b>06</b>
<b>2</b>	<b>Velocity Analysis:</b> Vectors, Displacement of a rigid body, Relative displacement, Definition of velocity, Angular velocity, Rotation of a rigid body, Translation and rotation of a rigid body, Relative velocity method (graphical and analytical), Instantaneous axes of motion, Properties of instantaneous centers, The Aronhold - Kennedy theorem of three centers, Velocity analysis by instantaneous centers. The line-of-centers method, Velocity analysis by components, Velocity images, Velocity diagrams.	<b>12</b>

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**Bachelor of Engineering**

**Subject Code: ME2204**

**Subject Name: Kinematics and Theory of Machines**

<b>3</b>	<p><b>Acceleration Analysis:</b> Definition of acceleration, Angular acceleration, A general case of acceleration, Radial and transverse components of acceleration, The coriolis component of acceleration, Examples of acceleration analysis, Acceleration diagrams.</p>	<b>12</b>
<b>SECTION-B</b>		
<b>4</b>	<p><b>Kinematics of Belts, Ropes and Chain Drives:</b> Introduction, Belt and rope drives, Open and crossed belt drives, Velocity ratio, Slip, Materials for belt and ropes, Law of belting, Length of belt, Ratio of friction tensions, Power transmitted, Centrifugal effect on belts, Maximum power transmitted by a belt, Initial tension, Creep, Chains, Chain length, Angular speed ratio, Classification of chains.</p>	<b>07</b>
<b>5</b>	<p><b>Kinematics of Gears:</b> Introduction, Classification of gears, Gear terminology, Law of gearing, Velocity of sliding, Forms of teeth, Cycloidal profile teeth, Involute profile Teeth, Comparison of Cycloidal and involute tooth forms, Path of contact, Arc of contact, number of pairs of teeth in contact, Interference in involute gears, Minimum number of teeth, Interference between rack and pinion, Undercutting, Introduction to helical, Spiral, Worm, Worm gear and bevel gears.</p>	<b>15</b>
<b>6</b>	<p><b>Kinematics of Cams:</b> Introduction, Types of cams, Types of followers, Cam terminology, Displacement diagrams, Motions of the follower, Graphical construction of cam profile, High Speed CAM.</p>	<b>08</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
15%	15%	15%	25%	25%	05%

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2204**

**Subject Name: Kinematics and Theory of Machines**

**Reference Books:**

1. Theory of Machines, Rattan S. S., Tata McGraw-Hill
2. Theory of Machines and Mechanisms, Uicker J. J. Jr., Pennock G. R., Shigley J. E., Oxford Press.
3. Kinematics and Dynamics of Machinery, Norton R. L., McGraw-Hill
4. Mechanism and Machine Theory, Ambekar, A. G., Prentice Hall
5. Theory of Machines, Singh Sadhu, Pearson Education

**List of Practical/ Tutorials:**

1. Velocity diagram using Instantaneous center method.
2. Velocity diagram using Instantaneous center method.
3. Velocity and acceleration analysis of mechanism involving coriolis component.
4. Layout of cam profile for reciprocating knife edge follower.
5. Layout of cam profile for offset reciprocating roller follower.
6. Layout of cam profile for offset reciprocating roller follower.
7. Layout of cam profile for oscillating follower.

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO Statement
CO-1	Understand basic structure and elements of machines.
CO-2	Determine position, velocity of linkages in mechanism at any instant.
CO-3	Determine position, velocity and acceleration of linkages in mechanism at any instant.
CO-4	Understand basic of Belts, Ropes and Chain Drives.
CO-5	Demonstrate an understanding of principle of gears.
CO-6	Demonstrate an understanding of principle of cams.

**List of Open-Source Software/Learning Website:**

<https://archive.nptel.ac.in/courses/112/105/112105268/>

<https://archive.nptel.ac.in/courses/112/104/112104121/>

<https://archive.nptel.ac.in/courses/112/106/112106270/>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2205**  
**Subject Name: Operation Research**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: IV**

**Type of course:** Basic Science

**Prerequisite:** Nil

**Rationale:** Operations Research now a day widely used in the area of decision making for the real life problems. Managers and decision makers get idea for optimizing and approximating industrial problems. They not only strive to devise appropriate measures for problem solving but also apply scientific techniques to monitor the organizations ongoing activities such as Production mix, Transportation, Assignment, Queuing, Game theory, Replacement and Project Management problem.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	0	0	100

**Content:**

Sr. No.	Content	Total Hrs.
SECTION-A		
1	<b>Operations Research:</b> Origin of Operation Research, Historical Standpoint, Methodology, Different Phases, Characteristics, Scope and Application of Operations Research.	3
2	<b>Linear Programming Problem:</b> Introduction, Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods, Analytical Methods: Simplex, Big M and Two Phase, Special Case of LP Problem, Introduction of Primal and Dual Problems, Economic Interpretation.	10
3	<b>Transportation and Assignment:</b> Transportation Problems definition, Linear form, Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. Transshipment Problems. Assignment Problems and Travelling sales man Problem.	7

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**Bachelor of Engineering**  
**Subject Code: ME2205**  
**Subject Name: Operation Research**

SECTION-B		
<b>4</b>	<p><b>Inventory Control:</b> Inventory classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands, ABC analysis.</p> <p><b>Replacement theory:</b> Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.</p>	8
<b>5</b>	<p><b>Game Theory:</b> Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods.</p> <p><b>Decision Theory:</b> Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, hurwicz criterion, Decision tree.</p>	8
<b>6</b>	<p><b>Project Management:</b> Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.</p>	4

**Suggested Specification table with Marks (Theory):**

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
<b>5%</b>	<b>20%</b>	<b>25%</b>	<b>25%</b>	<b>25%</b>	<b>0%</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**(Established under Gujarat Private Universities Act, 2009)**

**Bachelor of Engineering**  
**Subject Code: ME2205**  
**Subject Name: Operation Research**

**Reference Books:**

1. Operations Research – Theory and Applications b J. K. Sharma, Trinity Press, Laxmi Publications.
2. Operations Research by P. Rama Murthy, New Age International Publishers
3. Operations Research: An Introduction by HamdyTaha, Pearson Education Inc
4. Operations Research: Principles and Practice by Pradeep PrabhakarPai, Oxford Higher Education, Oxford University press
5. Operations Research: Principles and Practice by Ravindran Phillips and Solberg by Wiley India Edition,
6. Operations Research by P Mariappan, Pearson
7. Operations Research by A M Natarajan, P Balasubramani, A Tamilarasi, Pearson Education Inc
8. Operations Research by H N Wagner, Prentice hall.
9. Optimization in Operations Research by Ronald Rardin, Pearson Education Inc.
10. Operations Research by R. Paneerselvam, Prentice Hall of India Pvt. Ltd.
11. Quantitative Techniques in Management by N D Vohra, Tata McGraw-Hill

**List of Practical/ tutorials: Nil**

**Course Outcomes:**

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	To describe the characteristic, scope, and application of Operation Research in real life.
CO-2	To formulate the real-life problems into a mathematical form and use LPP techniques for optimization of production mix problem in industry.
CO-3	Evaluate transportation, assignment, transshipment and travelling salesman problems.
CO-4	Apply quantitative techniques in machine replacement and inventory control.
CO-5	Solve simple problems of game theory and decision theory.
CO-6	Demonstrate selection of critical path and reduction of project time in different problems related to network

**List of Open Source Software/learning website:**

<https://nptel.ac.in/>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**  
**Subject Code: ME2206**  
**Subject Name: Strength of Materials**

Shroff S.R. Rotary Institute of Chemical Technology

**Semester: IV**

**Type of course:** Professional Core Course

**Prerequisite:** System of units, Laws of motion, Basic idea of force, Concept of centroid & Moment of Inertia, Fundamentals of stress, strain and their relationships.

**Rationale:** This subject is conceptual applications of principles of mechanics of rigid and deformable bodies in Engineering.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	Statically Determinate Structures: Analysis of support reactions, beams, Consideration of concentrated loads, moments/couples, Uniformly Distributed Loads (UDL), Uniformly Varying Loads (UVL); Shear Force and Bending Moment Diagrams for Beams, Point of Contraflexures, Point and magnitude of Maximum bending moment and maximum shear force.	7
2	Friction: Theory of friction, Types of friction, Static and kinetic friction, Angle of repose, Coefficient of friction, Laws of friction, Application of theory of friction: Friction on inclined plane, ladder friction, wedge friction, belt and rope friction.	7
3	Torsion: Derivation of equation of torsion, Assumptions, application of theory of torsion equation to solid & hollow circular shaft, torsional rigidity, Power Transmitted by shaft.	7
<b>SECTION-B</b>		
4	Stresses in Beams: Flexural stresses – Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis,	9

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**Bachelor of Engineering**

**Subject Code: ME2206**

**Subject Name: Strength of Materials**

	determination of bending stresses, section modulus of rectangular & circular (solid & hollow), I,T,Angle, channel sections.	
<b>5</b>	Principal Stresses: Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress.	<b>6</b>
<b>6</b>	Physical & Mechanical properties of materials: Elastic, homogeneous, isotropic materials; Stress –Strain relationships for ductile and brittle materials, limits of elasticity and proportionality, yield limit, ultimate strength, strain hardening, proof stress, factor of safety, working stress, load factor, Properties: Toughness, hardness, Ductility, Brittleness.	<b>6</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>5%</b>	<b>35%</b>	<b>35%</b>	<b>20%</b>	<b>5%</b>	<b>0%</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Text Books:**

1. Dr. R.K.Bansal, "A Textbook of Strength of Materials", Sixth edition, Laxmi Publications, 2018.

**Reference Books:**

1. Dr. R.P. Rethaliya, Dr. V.R. Panchal, Dr. Y.D. Patil, "Mechanics of Solids", Edition, 1, Atul Prakashan, 2014-15.
2. Dr. B C Punamia, "Strength of Material & Mechanics of Structures, E-Book, 2019.
3. S. RAMAMURTHAN, R. Narayan, "Strength of Material", E-Book, 2005.
4. R.S.Khurmi, "Theory of Structures", S. Chand Publishing, New Delhi, 2000.
5. Indrajeet M. Jain, "Mechanics of Solids", Tech-Max Publications, 2012.

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**Bachelor of Engineering**  
**Subject Code: ME2206**  
**Subject Name: Strength of Materials**

**List of Practical/ tutorials:**

1. Verification of principle of moment: Bell crank lever.
2. Determination of Beam reactions.
3. Determination of Shear Force & Bending Moment Diagram of a beam.
4. Determination of impact of metals: Izod/Charpy impact test.
5. Determination of Compression strength for Metals/Timber
6. Determination of Principle stresses of a system.

**Course Outcomes:**

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Apply fundamental principles of mechanics & principles of equilibrium to simple and practical problems of engineering.
CO-2	Use principles of statics to determine reactions & internal forces in statically determinate beams.
CO-3	Know basics of friction and its importance through simple applications.
CO-4	Explain the different types of stresses and strains developed in the member subjected to axial, bending, shear & torsional effects.
CO-5	Understand the concept of principle stress & strain.
CO-6	Know behaviour & properties of engineering materials.

**List of Open Source Software/learning website:**

[www.nptel.iitm.ac.in/courses](http://www.nptel.iitm.ac.in/courses)  
<http://sm-nitk.vlabs.ac.in/>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2207**

**Subject Name: Fluid Mechanics and Fluid Machines**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: - IV**

**Type of course: Core subject**

**Prerequisite: Nil**

**Rationale:** This course imparts fundamental knowledge regarding fluid, types, properties, basic governing equations in static and moving conditions and various fluid machines used in the practice.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>Fluid statics:</b> Dimensions and units: physical properties of fluids- specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric gauge and vacuum pressure – measurement of pressure, Manometers- Piezometer, U-tube, inverted and differential manometers. Pascal’s law, hydrostatic law, Buoyancy and floatation: Meta center, stability of floating body, Submerged bodies, Calculation of metacenter height, Stability analysis and applications.	<b>6</b>
<b>2</b>	<b>Fluid kinematics:</b> Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, Fluid dynamics: surface and body forces –Euler’s and Bernoulli’s equations for flow along a stream line, momentum equation and its applications, force on pipe bend. Closed conduit flow: Reynold’s experiment, Darcy Weisbach equation- Minor losses in pipes, pipes in series and pipes in parallel, total energy line, hydraulic gradient line.	<b>6</b>
<b>3</b>	<b>Boundary Layer Theory and Dimensional analysis:</b> Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, Dimensional Analysis:	<b>6</b>

**(Established under Gujarat Private Universities Act, 2009)**

**Bachelor of Engineering**

**Subject Code: ME2207**

**Subject Name: Fluid Mechanics and Fluid Machines**

	dimensional analysis using Rayleigh’s method, Buckingham $\pi$ -theorem, Similitude and modelling – Dimensionless numbers	
<b>SECTION-B</b>		
<b>4</b>	<b>Impact of Jet and Hydraulic Turbines:</b> Force exerted on stationary flat and curved plates held normal, force exerted on moving plate held normal and on a plate when vane is moving in direction of jet, jet striking on curved vane tangentially at one tip and leaving at other end, classification of hydraulic turbines, impulse and reaction turbines, construction, working and analysis of Pelton, Francis and Kaplan turbines, draft tube, governing of the hydraulic turbines, cavitations, performance characteristics	<b>8</b>
<b>5</b>	<b>Centrifugal Pumps:</b> Pump classification and selection criterion, velocity vector diagrams, pump losses and efficiencies, net positive suction head, pressure rise in impeller, characteristic curves, priming	<b>5</b>
<b>6</b>	<b>Hydraulic Machines:</b> Hydraulic press, hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic jack, hydraulic lift, hydraulic ram, fluid couplings, fluid torque converter and air lift pump	<b>5</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>20</b>	<b>30</b>	<b>15</b>	<b>15</b>	<b>10</b>	<b>10</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom’s Taxonomy)**

**Reference Books:**

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S. K. Kataria & Sons
2. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Prakashan
3. Fluid Mechanics and Hydraulic Machines by R.K. Rajput, S.Chand & Co.
4. Theory and Applications of Fluid Mechanics by K. Subramanya, McGraw Education
5. Fluid Mechanics by Frank .M. White, McGraw Hill Education
6. Mechanics of Fluids by Shames, McGraw Hill Education

**List of Experiments:**

1. Verification of Bernoulli’s theorem

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**Bachelor of Engineering**

**Subject Code: ME2207**

**Subject Name: Fluid Mechanics and Fluid Machines**

2. To measure the velocity of flow using orifice meter and venturimeter.
3. To determine the coefficient of discharge through open channel flow over a notch.
4. To determine the different types of flow patterns by Reynolds' experiment.
5. To determine the friction factor for the different pipes.
6. To determine the loss coefficients for different pipe fittings.
7. To verify Impulse-momentum principle for impact of jet on stationary vane.
8. Performance test on Pelton turbine.
9. Performance test on Kaplan turbine.
10. Performance test on Francis turbine.
11. Performance test on centrifugal pump.

**Course Outcomes:**

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Understand various fluid properties and behavior of fluid in static mode
CO-2	Explain behavior of fluid in dynamic mode
CO-3	Make use of dimensional analysis and interpret types of fluid flow
CO-4	Analyze theory of impact of jet and apply the same for hydraulic turbine
CO-5	Evaluate performance of centrifugal pumps
CO-6	Understand working of various hydraulic machines

**List of Open Source Software/learning website:**

[nptel.ac.in](http://nptel.ac.in)

**(Established under Gujarat Private Universities Act, 2009)**

**Bachelor of Engineering**  
**Subject Code: ME2208**  
**Subject Name: Manufacturing Processes**

## Shroff S.R. Rotary Institute of Chemical Technology

**Semester: - IV**

**Type of course:** Programme Core course

**Prerequisite:** Knowledge of Basic mechanical workshop and various tools associated with manufacturing and fabrication work.

**Rationale:** Manufacturing, the major and the most important aspect in industries needs utmost care and attention. Knowledge about various processes and allied areas will be of great use to the personnel involved in production. This will provide the students an opportunity to skill themselves for the industrial scenario. This subject of Manufacturing Engineering provides knowledge regarding different types of manufacturing processes used to produce variety of metal products used in automobile and other machines and equipment. It also develops understanding that can be used to suggest and manipulate vital process parameters related to different manufacturing processes so that the high quality component may be produced at low cost and in minimum time.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	5	70	30	20	30	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>Introduction to manufacturing processes :</b> Nature, role and scope of manufacturing processes. Role of various fabrication processes like machining, forming, casting and joining processes in manufacturing of industrial components. Metal Cutting Principles: Primary cutting motions in machines tools, Cutting tool geometry and tool signature, cutting forces and power requirement in machining	<b>04</b>

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**Bachelor of Engineering**

**Subject Code: ME2208**

**Subject Name: Manufacturing Processes**

<b>2</b>	<p><b>Lathe Operations:</b> Types of lathes – light duty, Medium duty and heavy duty geared lathe, CNC lathe; Specifications; Basic parts and their functions; Operations carried on engine lathe, Types of lathe machines, attachment extending the processing capacities of engine lathes, Capstan and Turret lathes, Taper turning on lathe, Thread cutting on lathe using gear train and chasing dial, Alignment tests of lathes</p>	<b>09</b>
<b>3</b>	<p><b>Drilling Machines:</b> Purpose and field of application of drilling machines, Classification; Basic parts and their functions; Types of drilling machines, Drilling and allied operation: drilling, boring, reaming, tapping, counter sinking, counter boring, spot facing; deep hole drilling, alignment tests of drilling machine, Tool signature of drill, various field of application of boring machine, Types of boring machine-Horizontal boring machines, Precision boring machines.</p>	<b>08</b>
<b>SECTION-B</b>		
<b>4</b>	<p><b>Sawing and Broaching Machines:</b> Metal sawing classification: reciprocating sawing machines, circular sawing machines, band sawing machines, Types of broaching machines, advantage and limitations of broaching.</p> <p><b>Milling Machines:</b> Introduction; Types of milling machines: plain, Universal, vertical; constructional details – specifications; Milling operations: simple, compound and differential indexing; Milling cutters–types; Nomenclature of teeth; Teeth materials; Tool signature of milling cutter; Tool &amp; work holding devices.</p>	<b>09</b>
<b>5</b>	<p><b>Planers, Shapers and Slotters:</b> Classification of planers, Shapers and Slotters, Attachments extending the processing capacities of planers, Shapers and Slotters, machine and tooling requirements</p>	<b>04</b>
<b>6</b>	<p><b>Grinding Machines and Abrasives:</b> Principles of metal removal by Grinding, Classification of grinding machines, cylindrical grinders, internal grinders, Surface grinders, tool and cutter grinders, center less grinders, Types of grinding wheels, wheel characteristics and wheel selection. Standard marking systems: Meaning of letters &amp; numbers sequence of marking, Grades of letters.</p>	<b>08</b>

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**Bachelor of Engineering**

**Subject Code: ME2208**

**Subject Name: Manufacturing Processes**

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
<b>R Level</b>	<b>U Level</b>	<b>A Level</b>	<b>N Level</b>	<b>E Level</b>	<b>C Level</b>
<b>20</b>	<b>30</b>	<b>20</b>	<b>10</b>	<b>10</b>	<b>10</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Text Books:**

1. Elements of workshop Technology (Volume I & II) – S. K. Hajra Chaudary, Bose & Roy, Media Promoters and Publishers Limited.
2. Production Technology (Volume I & II) – O. P. Khanna & Lal, Dhanpat Rai Publications.

**Reference Books:**

3. Manufacturing Processes for Engineering Materials, Kalpakjian and Schmid, Prentice Hall. Fundamentals of Metal Machining and Machine Tools, Winston A. Knight, Geoffrey Boothroyd, CRC Press.
4. Manufacturing technology – P N Rao, Tata McGraw-Hill Publications.
5. Workshop Technology \_ B.S. Raghuvanshi, Dhanpat Rai and Co., New Delhi.
6. Manufacturing Technology, Metal Cutting & Machine tools– P. N. Rao, Tata McGraw-Hill Publications.
7. Workshop Technology I & II - J. A. Schey, Tata McGraw-Hill Publications.

**List of Practical/ tutorials:**

1. Study of various Machine Tools (Lathe, Shaper, Slotter, Planner).
2. Study of various cutting angles on Single point cutting tool.
3. Study of various turning operations like plain turning, facing, taper turning, knurling, threading, grooving, etc. performed on lathe machine
4. Turning Job: Prepare a job on centre lathe as per the given drawing.
5. Milling Job: Prepare a job on milling machine as per the given drawing using various milling operations.
6. Shaping and Drilling Job: Prepare a job having plain and inclined surfaces on shaping machine with minimum two holes as per given drawing.
7. Prepare a job using arc welding. This includes cutting of raw material and preparation of pre-weld parts and continuous welding in job. (Any of Lap joint, Lap Tee joint, Edge joint, Butt joint)

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**Bachelor of Engineering**

**Subject Code: ME2208**

**Subject Name: Manufacturing Processes**

8. Study of various sheet metal operations which can be performed on Press
9. Demonstration of Gear making process using Indexing mechanism on milling machine.
10. Study of various surface finishing processes like grinding, honing, lapping, super finishing

**Course Outcomes:**

At the end of the course, the student will be able to:

Sr. No.	CO statement
CO-1	<b>Understand</b> the concept and basic mechanics of metal cutting and working of standard machine tools
CO-2	<b>Demonstrate</b> various machining operation carried out at different machine tools.
CO-3	<b>Identify and control</b> the appropriate process parameters, and possible defects of manufacturing processes so as to remove them.
CO-4	<b>Generate</b> the sequence of machining operation to produce the end product with the aim of reduction of cost and manpower.
CO-5	<b>Get</b> idea of about the difficulties in metal cutting operations and the possible approaches to overcome them.
CO-6	<b>Describe</b> the effect of different grinding and abrasive parameters on surface integrity.

**List of Open Source Software/learning website:**

<http://nptel.iitm.ac.in/video.php?subjectId=112105126>

<http://nptel.iitm.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Manuf%20Proc%20II/pdf/LM-01.pdf>

**(Established under Gujarat Private Universities Act, 2009)**

**Bachelor of Engineering**

**Subject Code: ME2209**

**Subject Name: Mechanical Measurement & Metrology**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: IV**

**Type of course:** Programme Core Course

**Prerequisite:** Nil

**Rationale:** Measurement and Metrology deals with the application of science in Mechanical Engineering. It provides a means of assessing the suitability of measuring instruments, their calibration, and the quality control of manufactured products.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	5	70	30	30	20	150

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<p><b>Linear and Angular Measurement:</b>            Concept of linear measurement and its instruments: surface plate, V-block, calipers, combination set, depth gauge, vernier instruments, micrometer instruments, slip gauges, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, M112).            Concept of angular measurement; Instruments for angular Measurements; Use and working of universal bevel protractor, sine bar, spirit level; Principle of Working of Clinometers, Angle Gauges (With Numerical on Setting of Angle Gauges), Angle dekkor as an angular comparator.</p>	07

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**Bachelor of Engineering**

**Subject Code: ME2209**

**Subject Name: Mechanical Measurement & Metrology**

<b>2</b>	<p><b>Screw Thread Measurements:</b> Screw thread terminology, Errors in threads and Pitch; Measurement of different elements such as major diameter, minor diameter, effective diameter, pitch diameter, best size of wire Two wire method, Thread gauge micrometer; working principle of floating carriage micrometer; Introduction to Tool Makers Microscope, applications and working principle.</p> <p><b>Gear Measurement:</b> Analytical and functional inspection of Gear, Measurement of tooth thickness by constant chord method and base tangent Method by Gear Rolling tester / Parkinsons Gear Tester; Measurement of tooth thickness by Gear tooth Vernier and Profile projector Errors in gears such as backlash, run out.</p>	<b>08</b>
<b>3</b>	<p><b>Metrology of Surface Finish:</b> Primary and secondary texture, terminology of surface texture as per IS 3073-1967, CLA, Ra, RMS, Rz values and their interpretation, Symbol for designating surface finish on drawing; Various techniques of qualitative analysis, working principle of stylus probe type instruments, Surface Roughness Tester, Interferometry; Parallelism, Straightness, Squareness, roundness, run out, alignment tests of Lathe and Drilling, machine tools as per IS standard; Flatness testing using Monochromatic light source with optical flat, Introduction to CMM.</p>	<b>06</b>
<b>SECTION-B</b>		
<b>4</b>	<p><b>Measurement Systems and Basic Concepts of Measurement Methods:</b> Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response time delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers.</p>	<b>07</b>
<b>5</b>	<p><b>Force, Torque, Power, Displacement, Velocity/Speed, and Acceleration Measurement:</b> Force measurement: load cells, cantilever beams, proving rings, differential transformers. Measurement of torque: Torsion bar dynamometer, servo-controlled dynamometer, absorption dynamometers. Power Measurements, strain gauges for force and torque measurement, Strain gauge-based load cells and torque sensors, Working principal of</p>	<b>08</b>

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**Subject Code: ME2209**

**Subject Name: Mechanical Measurement & Metrology**

	Resistive Potentiometer, Linear variable differential transducers, Electro Magnetic Transducers, Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer.	
<b>6</b>	<b>Temperature and Pressure Measurement:</b> Temperature Measuring Devices: Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure Thermometers, Pyrometer, Bimetallic strip. Calibration of temperature measuring devices, Pressure measurement, principle, pitot tube, pressure gauges, pressure transducers, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.	<b>06</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
10%	10%	35%	00%	40%	0%

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate  
C: Create and above Levels (Revised Bloom's Taxonomy)**

**Reference Books:**

1. Engineering Metrology and Measurements, Bentley, Pearson Education.
2. Metrology and Measurement, Anand Bewoor & Vinay Kulkarni McGraw-Hill.
3. Mechanical Measurements and Instrumentations, Er. R. K. Rajput, Kataria Publication (KATSON).
4. Mechanical Measurement and Metrology by R. K. Jain, Khanna Publisher.
5. Mechanical Measurement & Control by D.S. Kumar, Metroplitan Book Co. Pvt. Ltd.
6. Industrial Instrumentation & Control by S. K. Singh, McGraw-Hill.
7. Engineering Metrology and Measurement, N. V. Raghavendra and Krishnamurthy, Oxford University Press.

**List of Practical/ Tutorials:**

1. Basic understanding of measurements and metrology: concepts, application, advantage and future aspects.
2. Performance on linear and angular measurements and check different characteristics of measurements.

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3. Performance on temperature measurements and check different characteristics of measurements.
4. Performance on pressure measurements and check different characteristics of measurements.
5. Performance on stress, strain and force measurements and check different characteristics of measurements.
6. Performance on Speed/Velocity, acceleration measurements.
7. Performance on surface measurements.
8. Performance on measurements of gears and screw threads.

**Course Outcomes:**

At the end of the course, the student will be able to:

<b>Sr. No.</b>	<b>CO Statement</b>
CO-1	To Describe basic concepts of Metrology and select linear and angular measuring instrument for measurement of various components.
CO-2	To Discriminate between various screws by measuring their dimensions and will separate different gears through measurement of various dimensions of gears.
CO-3	To Demonstrate quality of surface produced using various methods and also discriminate capabilities of machining process by measuring surface finish of the component produced.
CO-4	To analyze basic concepts of mechanical measurement and errors in measurements.
CO-5	To evaluate methods of measurement for various quantities like force, torque, power, displacement, velocity/seed and acceleration.
CO-6	To recognize appropriate temperature and pressure measuring device for various applications.

**List of Open-Source Software/Learning Website:**

<https://archive.nptel.ac.in/courses/112/106/112106138/>

<https://archive.nptel.ac.in/courses/112/106/112106139/>

(Established under Gujarat Private Universities Act, 2009)

**Bachelor of Engineering**

**Subject Code: ME2212**

**Subject Name: Oil Hydraulics and Pneumatics**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: - IV**

**Type of course:** Professional Elective Course-I

**Prerequisite:** Nil

**Rationale:** Course gives idea about the basic system working on fluid power and compressed air. Also different valves related to hydraulic and pneumatic systems are discussed in syllabus. Subject is also useful for designing the various hydraulic and pneumatic circuits for various engineering applications.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	0	2	70	30	0	0	100

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>Introduction:</b> Introduction, Global fluid power Scenario, Basic system of Hydraulics-Major advantages and disadvantages, Comparison among Electrical, Hydraulics and Pneumatics System, Principles of Hydraulic Fluid power, Hydraulic Symbols, Electrical Elements used in hydraulic circuits. Basic Requirements for Pneumatic System, Basic Symbols of Pneumatic Systems, Applications of Pneumatics. Electrical elements used in Pneumatic System. Types, Properties, physical characteristics & functions of hydraulic Oils, Classification Mineral based, Fire resistant & Biodegradable Oils, Filters, Contaminations, location of filter.	<b>6</b>
<b>2</b>	<b>Hydraulic Pumps, Motors, Valves and Actuators:</b> Classification of hydraulic pumps, Gear Pumps, Vane Pumps, Piston Pumps, Axial piston pumps, Hydraulic motors, Direction control valves, Pressure control valves, Flow control valves, Non-return valves, Reservoirs, Accumulators, Heating & cooling devices, Hoses. Types of Hydraulic Actuators, Selection criterion of Actuators, Linear and Rotary Actuators, Hydrostatic Transmission Systems.	<b>6</b>

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**Subject Code: ME2212**

**Subject Name: Oil Hydraulics and Pneumatics**

<b>3</b>	<b>Air Preparation and Service Unit:</b> Types & Selection criteria for Air Compressors, Air receiver, Pipeline Layout, Air filter, Pressure regulator and Lubricator (FRL unit).	<b>6</b>
<b>SECTION-B</b>		
<b>4</b>	<b>Pneumatic Cylinders, Motors and Valves:</b> Types of Pneumatic Cylinders & Air motors, Cushion assembly, mounting Arrangements, Pneumatic Direction control valves, Quick exhaust, Time delay Shuttle and Twin pressure valves.	<b>8</b>
<b>5</b>	<b>Circuit Design:</b> Basic hydraulic circuits, Industrial hydraulic circuits, Power losses in flow control circuits, Basic pneumatic circuits, Development of single Actuator Circuits, Development of multiple Actuator Circuits, Cascade method for sequencing.	<b>5</b>
<b>6</b>	<b>Automation and Simulation of Hydraulics and Pneumatics:</b> Introduction to Automation in hydraulic and Pneumatic Systems, Case study of Automation using Hydraulics and pneumatics. Introduction to software of hydraulic and Pneumatic system, Circuit designing in software, Simulation in software, Simulation with actual component using software like automation in industry.	<b>5</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>15</b>	<b>25</b>	<b>30</b>	<b>10</b>	<b>10</b>	<b>10</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)**

**Reference Books:**

1. Industrial Hydraulics by John Pippenger and Tyler Hicks, McGraw Hill.
2. Oil Hydraulic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
3. Fluid Power with Applications by Anthony Esposito, Pearson.
4. Fluid Power: Generation, Transmission and Control, Jagadeesha T., Thammaiah Gowda, Wiley.
5. The Analysis & Design of Pneumatic Systems by B. W. Anderson, John Wiley.

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**Subject Name: Oil Hydraulics and Pneumatics**

6. Control of Fluid Power Analysis and Design by Mc Clay Donaldson, Ellis Horwood Ltd.
7. Hydraulic and Pneumatic Controls: Understanding made Easy, K. Shanmuga Sundaram, S. Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)
8. Basic Pneumatic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.

**Course Outcomes:**

Sr. No.	CO statement
CO-1	Understand the working of basic components of hydraulic and pneumatic system.
CO-2	Identify and analyse the functional requirements of different important components of Hydraulic and Pneumatic System.
CO-3	Visualize how the hydraulic/pneumatic circuit will work to accomplish the function.
CO-4	Selection and sizing of components of the hydraulic and pneumatic system.
CO-5	Evaluate the performance of hydraulic and pneumatic system and do corrections if needed.
CO-6	Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application. Develop a circuit diagram.

**List of Open Source Software/learning website:**

[nptel.ac.in](http://nptel.ac.in)

Simulation software of Hydraulic and Pneumatic

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**Bachelor of Engineering**  
**Subject Code: ME2211**  
**Subject Name: Lubrication Technology**

**Shroff S.R. Rotary Institute of Chemical Technology**

**Semester: IV**

Type of course: Lubrication Technology

Prerequisite: Zeal to learn the subject

Rationale: The objective of this Course is to provide an introductory treatment of engineering lubrication and fuels to all the students of engineering, an understanding of the mechanical behaviour of lubrications under various load conditions. It gives the knowledge about Lubrication Principles, Lubricants Performance and failure analysis of machine component.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	-	-	2	70	30	-	-	100

**Content:**

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
<b>1</b>	<b>MANUFACTURE OF FUELS AND LUBRICANTS</b> Structure of petroleum, refining process, fuels, thermal cracking, catalytic cracking, polymerization, alkylation, isomerization, blending, and products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.	<b>6</b>
<b>2</b>	<b>THEORY OF LUBRICATION</b> Engine friction: introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elasto hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system.	<b>6</b>
<b>3</b>	<b>LUBRICANTS</b> Specific requirements for automotive lubricants, oxidation deterioration and degradation of lubricants, additives and additive mechanism, synthetic lubricants, classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, classification, properties, test used in grease.	<b>6</b>

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**Subject Name: Lubrication Technology**

<b>SECTION-B</b>		
<b>4</b>	<b>INDUSTRIAL LUBRICATION</b> Industrial lubrication – methods – manual – drop feed ,wick feed, splash – forced aerosol lubrication, pressure circulating system, centralized lubrication system, built in lubrication, pumps, instrumentation and control, lubrication of specific equipment, electric motor, automotive engines, machine tools, precision grinder, central lathe, construction equipment	<b>5</b>
<b>5</b>	<b>ORGANISATION OF LUBRICATION PROCESS</b> Lubrication Organization -Records And Scheduling – Handling And Storage ,Lubrication Condition And Disposal – Marketing – Conservation Of Lubrication ,Recycling Of Used Lubricants – Re Doping -Disposal Of Sludge, Lubrication Chart For Machine Tool -Lathe, Milling Machine	<b>6</b>
<b>6</b>	<b>LUBRICATION PERFORMANCE EVALUATION</b> Lubricant performance evaluation , lubricants for specific applications ,turbine oils ,engine oils , cutting fluids, cylinder oils, hydraulic oils – rust preventives – anti oxidants -oxidation stability – standard test for physical & chemical properties – film strength test, falex machine, Almen machine – SAE machine – acidity, basicity, neutralization number -aniline point – carbon residue – cloud, pour and flock points flash and fire point -foaming – penetration of greases – precipitation number – dropping point of grease. Engine performance test, thermal stability, oxidation stability – rust and corrosion prevention.	<b>6</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>25%</b>	<b>35%</b>	<b>30%</b>	<b>10%</b>	<b>NA</b>	<b>NA</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels**

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**Bachelor of Engineering**  
**Subject Code: ME2211**  
**Subject Name: Lubrication Technology**

**TEXT BOOKS**

1. Ganesan.V., “Internal Combustion Engineering”, Tata McGraw-Hill Publishing Co., New Delhi, 2003.
2. M.L. Mathur, R.P.Sharma “A course in internal combustion engines”, Dhanpatrai publication, 2003.
3. 4.Industrial Maintenance by H. P. Garg.

**REFERENCES**

1. Brame, J.S.S. and King, J.G. – Fuels – Solids, Liquids, Gaseous.
2. Francis, W – Fuels and Fuel Technology, Vol. I & II
3. Hobson, G.D. & Pohl.W- Modern Petroleum Technology
4. A.R.Lansdown – Lubrication – A practical guide to lubricant selection – Pergamon press – 1982.
5. Raymond.C.Gunther – Lubrication – Chilton Book Co., - 1971.

**List of Open Source Software/learning website:**

<https://nptel.ac.in>

**Course Outcomes:**

Sr. No.	CO statement
CO-1	Understand the basic types, manufacturing process and cracking.
CO-2	Understand the concepts of friction in lubrication systems.
CO-3	Understanding the concept of oil lubrication
CO-4	Understand the concepts of Industrial Lubrication
CO-5	Analyse the Organization of Lubrication process.
CO-6	Evaluation knowledge about the Lubrication Performance

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**Bachelor of Engineering**  
**Subject Code: ME2212**  
**Subject Name: Control System**

## Shroff S.R. Rotary Institute of Chemical Technology

### Semester: IV

**Type of course:** Professional Elective Course-I

**Prerequisite:** Fundamentals of complex variables and Laplace transform

**Rationale:** Automatic control of industrial processes is essential for increasing the output and in turn the profit of an industry. As a result, most of the companies are using automatic control of the machineries and processes. As an engineer, a student must know the basics of automatic control system. This subject is intended to supplement the basic skill of an engineer.

#### Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	0	2	70	30	0	0	100

#### Content:

Sr. No.	Content	Total Hrs.
<b>SECTION-A</b>		
1	<b>Introduction to control System:</b> Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.	3
2	<b>Time Response Analysis:</b> Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time response. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.	5

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**Subject Code: ME2212**  
**Subject Name: Control System**

<b>3</b>	<b>Frequency-response analysis:</b> Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.	<b>4</b>
<b>SECTION-B</b>		
<b>4</b>	<b>Controller Design Stability:</b> Steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers.	<b>4</b>
<b>5</b>	<b>State variable Analysis:</b> Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigen values and Stability Analysis.	<b>5</b>
<b>6</b>	<b>Controllability and observability:</b> Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.	<b>3</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>20</b>	<b>30</b>	<b>20</b>	<b>20</b>	<b>10</b>	<b>0</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom’s Taxonomy)**

**Text Books:**

1. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009.

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**Bachelor of Engineering**  
**Subject Code: ME2212**  
**Subject Name: Control System**

**Reference Books:**

1. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.
2. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.
3. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.

<b>Sr. No.</b>	<b>CO statement</b>
CO-1	Understand the fundamental of feedback control system.
CO-2	Understand time response specifications and determine the (absolute) stability of a closed-loop control system.
CO-3	Determine the time and frequency-domain responses of first and second-order systems to step and other standard inputs.
CO-4	Design controller as per given specifications using different techniques
CO-5	Express and solve system equations in state-variable form.
CO-6	Understand the concept of Controllability and observability.

**List of Open Source Software/learning website:**

E-materials available at the website of NPTEL-  
[http://nptel.ac.in/https://lbre.stanford.edu/sem/energy\\_conservation](http://nptel.ac.in/https://lbre.stanford.edu/sem/energy_conservation)