SOLAPURUNIVERSITY, SOLAPUR

FACULTY OF ENGINEERING & TECHNOLOGY

MECHANICAL ENGINEERING

Syllabus Structure for

T.E. (Mechanical Engineering)
w. e. f. Academic Year 2018-19

Choice Based Credit System

SOLAPUR UNIVERSITY, SOLAPUR
FACULTY OF ENGINEERING & TECHNOLOGY
Mechanical Engineering

Programme Educational Objectives and Outcomes

A. Program Educational Objectives (PEOs)

1. To make students competent for professional career in Mechanical & allied fields.
2. To build strong fundamental knowledge amongst student to pursue higher education and continue professional development in Mechanical & other fields
3. To imbibe professional ethics, develop team spirit and effective communication skills to be successful leaders and managers with a holistic approach.
4. To nurture students to be sensitive to ethical, societal & environmental issues while conducting their professional work.

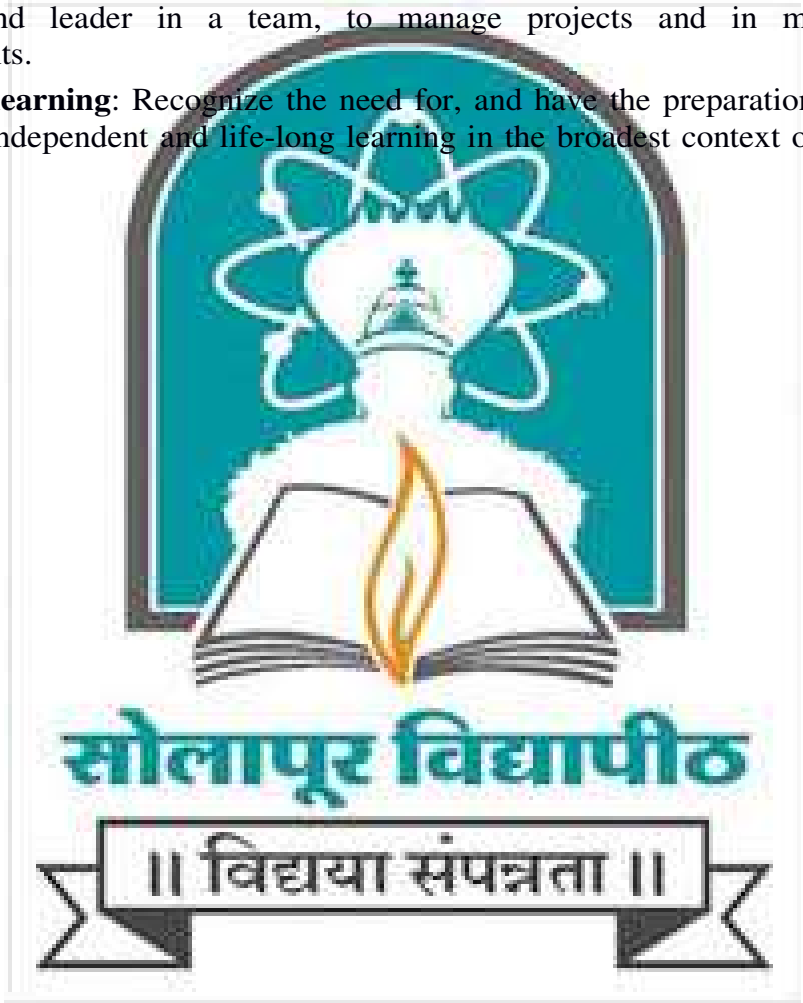
B. Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: User research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities

and norms of the engineering practice.

9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology

Structure of CBCS Curriculum for Third Year (Mechanical Engineering) w .e. f .2018-19

Semester I : Theory Courses

Course code	*Name of Theory Course*	Hrs./week				Credits	Examination Scheme			
		L	T	P	D		ISE	ESE	ICA	Total
ME311	Theory of Machine -II	3	-	-	-	3	30	70	-	100
ME312	Metrology and Mechanical Measurement	3	-	-	-	3	30	70	-	100
ME313	Metallurgy	3	-	-	-	3	30	70	-	100
ME314	Machine Design -I	3	-	-	-	3	30	70	-	100
ME315	Professional Elective -III	3	-	-	-	3	30	70	-	100
SLH31	Self Learning Course I -HSS	-	-	-	-	2	-	50		50
	Sub Total	**15**	**-**	**-**	-	**17**	**150**	**400**		**550**

Semester I: Laboratory / Tutorial Courses

Course code	*Name of Laboratory /Tutorial Course*	*Hrs./week*				*Credits*	*Examination Scheme*				
		L	*T*	*P*	D		*ISE*	*ESE*		*ICA*	*Total*
								POE	*OE*		
ME311	Theory of Machine -II	-	-	2	-	1	-	-	25	25	50
ME312	Metrology and Mechanical Measurement	-	-	2	-	1	-	-	-	25	25
ME313	Metallurgy	-	-	2	-	1	-	-	25	25	50
ME314	Machine Design -I	-	-	2	-	1	-	-	-	25	25
ME315	Professional Elective -III	-	-	2	-	1	-	-	-	25	25
ME316	Advanced Computer Programming -I	1	-	2	-	2	-	-	-	50	50
ME317	Workshop Practices -IV	-	-	2	-	1	-	-	-	50	50
	Sub Total	-	-	14	-	8	-	-	50	225	275
	Grand Total	**16**	**-**	**14**	-	**25**	**150**	**450**		**225**	**825**

Abbreviations:*L- Lectures, P –Practical, T- Tutorial, ISE- In Semester Examination, ESE - End Semester Examination (University Examination for Theory & / POE & / Oral), ICA- Internal Continuous Assessment.*

Professional Elective –III: Machine Tool Design, Material Handling System, Fluid Machinery & Fluid Power

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology

Structure of CBCS Curriculum for Third Year (Mechanical Engineering) w. e. f 2018-19

Semester II : Theory Courses

Course code	*Name of Theory Course*	Hrs./week				Credits	Examination Scheme			
		L	T	P	D		ISE	ESE	ICA	Total
ME321	Heat and Mass Transfer	3	-	-	-	3	30	70	-	100
ME322	Internal Combustion Engine	3	-	-	-	3	30	70	-	100
ME323	CAD-CAM & CAE	3	-	-	-	3	30	70	-	100
ME324	Machine Design -II	3	-	-	-	3	30	70	-	100
ME325	Professional Elective -IV	3	-	-	-	3	30	70	-	100
ME326	Self Learning Course II-Technical	-	-	-	-	2	-	50	-	50
	Sub Total	**15**	**-**	**-**	**-**	**17**	**150**	**400**	**-**	**550**

Semester II: Laboratory / Tutorial Courses

Course code	*Name of Laboratory / Tutorial Course*	*Hrs./week*				*Credits*	*Examination Scheme*				
		L	*T*	*P*	D		*ISE*	*ESE*		*ICA*	*Total*
								POE	*OE*		
ME321	Heat and Mass Transfer	-	-	2	-	1	-	25	-	25	50
ME322	Internal Combustion Engine	-	-	2	-	1	-	-	-	25	25
ME323	CAD-CAM & CAE	-	-	2	-	1	-	-	-	25	25
ME324	Machine Design -II	-	-	2	-	1	-	-	25	25	50
ME325	Professional Elective - IV	-	-	2	-	1	-	-	-	25	25
ME327	Advanced Computing Techniques'-II	1	-	2	-	2	-	-	-	50	50
ME328	Workshop Practice –V	-	-	2	-	1	-	25#	-	25	50
	Sub Total	-	**-**	14	-	08	-	75		200	275
	Grand Total	**16**	-	**14**	-	**25**	**150**	**475**		**200**	**825**

Abbreviations: *L- Lectures, P –Practical, T- Tutorial, ISE- In Semester Examination, ESE - End Semester Examination (University Examination for Theory & / POE & / Oral), ICA- Internal Continuous Assessment.*

Professional Elective – IV: Experimental Stress Analysis, Mechanical Vibration, Tool engineering # Indicates practical Examination only.

- **Note –**

1. Batch size for the practical /tutorial shall be of 15 students. On forming the batches, if the strength of remaining students exceeds 07, then a new batch shall be formed.
2. Industrial Training (evaluated at B.E. Sem.-I) of minimum 15 days shall be completed in any vacation after S.E. Sem.-II, may be Maximum in two slots but before B.E. Sem.-I & the report shall be submitted and evaluated in B.E. Sem.-I.
3. Students shall select one Self Learning Module at T.E. Sem. I and T.E. Sem. II each from Humanities and Social Sciences and Technical Groups Respectively.
4. Curriculum for Humanities and Social Sciences Self Learning Modules is common for all under graduate programmes of faculty of Engineering and Technology.
5. Minimum four assignments for Self Learning Modules at T.E. Sem.-I be submitted by the students which shall be evaluated by a Module Coordinator assigned by institute / department.
6. **for TE Part I -**

A. Student can select a Self Learning Course from Solapur University, Solapur HSS Course List and appear for its examination as and when conducted by Solapur University, Solapur

OR

B. Student can enroll for National Programme on Technology Enhanced Learning (NPTEL) course, complete its assignments and appear for certificate examination as and when conducted by NPTEL.

For more details about Self Learning Course (HSS) please refer to separate rule document available from Solapur University, Solapur

More details about NPTEL are available at http://nptel.ac.in

7. ICA assessment shall be a continuous process based on student's performance in class tests, assignments, homework, subject Seminars, quizzes, laboratory books and their interaction and attendance for theory and laboratory sessions as applicable

Solapur University, Solapur

T.E. (Mechanical Engineering) Semester-I

ME311 Theory of Machines – II

Teaching Scheme
Lectures– 3 Hours/week, 3 Credits
Tutorial – 2 Hour/week/batch, 2 Credits

Examination Scheme
ESE– 70 Marks
ISE –30 Marks
ICA- 25 Marks
Oral Exam: 25Marks

Course Introduction:
This course provides detail information about gear terminology, efficiency of spiral gear, interference phenomenon. Different kinds of gear trains and their speed calculations are included in this course. Basics of flywheel with its size calculations are also covered. Introduction of gyroscope, its couple and effect in various applications like aero plane, ship, two wheeler and four wheeler is also covered in this course. This course also seeks to provide an introduction to balancing of rotary and reciprocating masses. Also covers balancing of single cylinder, multi cylinder inline engine, V engine. It introduces basics of vibration and describes the frequencies of longitudinal, transverse and torsional vibrations. It also covers types of vibrations and damping methods.

Course Prerequisite: Student shall have knowledge of basics from theory of machines I like linkage, degree of freedom. Basic knowledge of gear train, gear, mathematics and analysis of mechanical element is essential for successful completion of this course.

Course Objectives: During this course, student is expected
1) To Study design of gears, gear trains and their applications
2) To Learn concept & design of flywheel & applications of gyroscope
3) To understand the concepts of balancing & vibration

Course Outcomes: At the end of this course, student will be able to
1) To select gear and gear train as per requirement
2) To design different types of gear trains
3) To review turning moment diagram & design flywheel for various applications
4) To judge the effect of gyroscopic couple on different vehicles
5) To perform balancing of rotary and reciprocating masses
6) To solve the issue related to vibration and damping

Section - I

Unit 1– Toothed Gearing. **No of lectures – 06**

- **Prerequisite:** Knowledge of gear, materials and mathematics.
- **Objectives:**
    1. To understand gear terminology, interference concept and gear profiles.
    2. To calculate centre distance and efficiency of spiral gears.
- **Outcomes:** After completing this unit, student will be able to
    1. Explain different terms used for gear.
    2. Calculate efficiency of gear

• **Unit Content:**

Geometry of motion, Gear geometry, Types of gear profile- involutes &cycloidal, Theory of Spur, Helical & Spiral gears, Interference in involute tooth gears and methods for its prevention, Contact ratio, Path of contact, Efficiency and center distance of spiral gears.

• **Content Delivery Methods:** Board, Chalk and talk, animations

• **Assessment Methods:**

Questions based on Definition of gear terminology, types of gear profiles, interference of gear, methods to prevent interference, derivation and numerical on centre distance, and efficiency of spiral gears, derivation and numerical on length of path of contact, arc of contact and contact ratio

Unit 2– Gear Trains **No of lectures – 05**

• **Prerequisite:** Knowledge of gear, analysis of mechanical elements, automobile basics.

• **Objectives:**

1. To understand different applications of various gear trains.
2. To calculate revolutions of elements in gear train.

• **Outcomes:** After completing this unit, student will be able to.

1. Calculate speed of elements in gear train.
2. Select proper gear train for specific application.

• **Unit Content:**

Types of Gear trains- Simple, Compound, Epicyclic, Reverted gear train, Tabular method for finding the speeds of elements in simple and compound epicyclic gear train, Differential gear box.

• Content Delivery Methods: Board, Chalk and talk, videos

• Assessment Methods: Questions based on types of gear train, revolution calculation of epicyclic gear train by tabular method, construction and working of differential gear box, numerical on epicyclic gear train

Unit 3– Turning Moment diagram and Flywheel **No of lectures – 04**

• **Prerequisit**e: basic mechanical engineering, mathematics

• **Objectives:**

1. To understand working of flywheel and differentiate its working with governor.
2. To calculate size of flywheel.

• **Outcomes:** After completing this unit, student will be able to

1. Differentiate between governor and flywheel for application
2. Understand coefficient of fluctuation of energy and coefficient of fluctuation of speed
3. Calculate size of flywheel, coefficient of fluctuation of energy and speed.

• **Unit Content:**

Function of flywheel and study of turning moment diagrams. Coefficient of fluctuation of speed energy. Determination of size of the flywheel for various applications.

• **Content Delivery Methods:** Board, Chalk and talk

• **Assessment Methods:** Questions based on definitions of fluctuation of energy, coefficient of fluctuation of energy, coefficient of fluctuation of speed, coefficient of steadiness, derivation for size of flywheel, numerical on size of flywheel

Unit 4– Gyroscope. **No of lectures – 05**

• **Prerequisite:** Concepts of applied mechanical engineering, basics of automobile

• **Objectives:**

1. To understand the concept of gyroscopic couple and effect.
2. To find out effect of gyroscopic couple on aero plane, ship, two wheeler and four wheeler.

• **Outcomes:** After completing this unit, student will be able to-

1. Understand and calculate effect of gyroscopic couple.
2. Calculate gyroscopic couple for aero plane, ship, two wheeler and four wheeler.

• **Unit Content:** Gyroscopic couple, Spinning and Processional motion, Gyroscopic couple and its effect on i) Aero plane ii) Ship iii) Four-Wheeler iv) Two –Wheeler

• **Content Delivery Methods:** Board, Chalk and talk

• **Assessment Methods:** Questions based on effect of gyroscope on aero plane, ship, two wheeler and four wheeler, numerical on gyroscopic couple and effect on aero plane, ship, two wheeler and four wheeler.

Section - II

Unit 5–Balancing **No of lectures – 07**

• **Prerequisite:** Knowledge of force analysis of reciprocating engine mechanism, applied mechanics.

• **Objectives:**

1. To learn balancing process for rotary and reciprocating masses.
2. To understand balancing of single cylinder, multi cylinder inline engines, V engines

• **Outcomes:** After completing this unit, student will be able to

1. Calculate primary and secondary forces and couples.
2. Do balancing of rotary, reciprocating, single cylinder, multi cylinder, V engines.

• **Unit Content:**

Static and Dynamic balancing of rotary and reciprocating masses. Primary and Secondary forces and couples. Direct and Reverse cranks. Balancing of Single cylinder, Multi cylinder-In-line and V-Engines.

• **Content Delivery Methods:** Board, Chalk and talk

• **Assessment Methods:** Questions based on types of balancing of rotary masses, partial balancing of reciprocating masses, direct and reverse crank method, balancing of V engines, numerical on balancing of rotary masses, reciprocating masses, multi cylinder inline engine, V engine.

Unit 6– Basic concepts of Vibrations. **No of lectures – 03**

- **Prerequisite:** Knowledge of physics, basic mechanical engineering.
- **Objectives:**
    1. To learn basic terms and definitions used in vibrations
    2. To understand relations between vibrations, displacement, velocity and acceleration
    3. To learn types of vibrations
- **Outcomes:** After completing this unit, student will be able to
    1. Define terms used in vibrations
    2. Differentiate types of vibrations
    3. Solve numerical on equivalent springs
- **Unit Content:**

Basic concepts and definitions, terms used in vibratory motion, vibration measuring parameters- Displacement, Velocity and acceleration. Types of vibrations, Equivalent Springs.

- **Content Delivery Methods:** Board, Chalk and talk
- **Assessment Methods:** Questions based on definitions used in vibration, types of vibrations, equivalent springs, numerical on equivalent springs

Unit 7 -Longitudinal and Transverse vibrations. **No of lectures – 07**

- **Prerequisite:** Physics, mathematics.
- **Objectives:**
    1. To understand free and forced vibrations.
    2. To learn longitudinal and transverse vibrations and their frequencies.
    3. To learn types of damping.
    4. To understand concepts of magnification factor, vibration isolation and whirling speed of shaft
- **Outcomes:** After completing this unit, student will be able to
    1. Differentiate between longitudinal and transverse vibrations.
    2. Differentiate between free and forced vibration.
    3. Calculate frequency of free and forced vibration.
    4. Clear with concepts of vibration isolation, whirling of shafts, damping
- **Unit Content:**

Free vibrations with and without damping (Rectilinear & Transverse), natural frequency of free longitudinal vibration and transverse vibrations, Logarithmic decrement, types of damping, equivalent viscous damping, Coulomb damping, Forced vibrations with viscous damping, magnification factor, frequency response curves, vibration isolation and transmissibility (No numerical treatment to forced vibrations), Whirling of Shafts and Critical speeds

- **Content Delivery Methods:** Board, Chalk and talk, animated videos
- **Assessment Methods:** Questions based on derivation of natural frequency of longitudinal and transverse vibration, logarithmic decrement, types of damping,

magnification factor, vibration isolation and transmissibility, whirling speed of shaft, numerical on frequency of free vibrations, whirling speed of shaft.

Unit 8– Torsional Vibrations **No of lectures – 03**

- **Prerequisite:** Knowledge of measurement methods, mathematics.
- **Objectives:**
    1. To develop concept of torsional vibrations
    2. To understand single rotor, two rotor and three rotor system
    3. To get introduction to FFT analyzer
- **Outcomes:** After completing this unit, student will be able to
    1. To find out frequency of torsional vibration with single rotor, two rotor and three rotor system
    2. To calculate frequency of torsionally equivalent shaft
- **Unit Content:** Introduction, natural frequency of torsional vibration, free torsional vibrations of single rotor system, free torsional vibration of two rotor and three rotor system, torsionally equivalent shafts, introduction to FFT analyzer
- **Content Delivery Methods:** Board, Chalk and talk
- **Assessment Methods:** Questions based on derivation of natural frequency of torsional vibration, single rotor, two rotor and three rotor system, derivation of torsionally equivalent shaft, introduction of FFT analyzer, numerical on torsionally equivalent shaft
- **Internal Continuous Assessment (ICA):** (First four experiments are compulsory & Any three from 5 to8)
    1. Experiment to generate involutes gear tooth profile.
    2. Two Problems on each type of Epicyclic gear train using tabular method.
    3. Experiment on Gyroscope.
    4. Balancing of rotary masses (Static and Dynamic).
    5. Determination of MI by Bi-filar suspension, Trifilar suspension or compound pendulum.
    6. Experiment on free longitudinal vibration of Helical Spring.
    7. Experiment on forced vibration characteristics (Undamped damped)
    8. Experiment on Free Torsional Vibration of Two Rotor System

Text Books:

1. Theory of Machines by Khurmi Gupta
2. Theory of Machines by Rattan S.S.
3. Theory of Machines by Thomas Bevan.
4. Mechanical Vibrations by Grover

- **Reference Books:**

1. Theory of Machines & Mechanisms by Shigley
2. Mechanism and Machine Theory by Rao, Dukkipati.
3. Theory of Machines by Dr. V.P. Singh
4. Theory of Machines by Ballaney
5. The complete Automotive Technology by William Crouse Angline
6. Mechanical Vibrations by Dr. V.P. Singh
7. Theory Machines and Mechanisms by Sayyad F.B. and Singhal

Solapur University, Solapur

T.E. (Mechanical Engineering) Semester-I

ME312 Metrology and Mechanical Measurement

Teaching Scheme	**Examination Scheme**
Lectures– 3 Hours/week, 3 Credits	**ESE– 70 Marks**
Practical – 2 Hour/week, 1 Credit	**ISE –30 Marks**
	ICA- 25 Marks

Course Introduction:

This course seeks to provide an introduction to measurements and to concepts and terms related to it. The subject covers working of generalized measuring systems and elements in it. The course provides information about the principle and working of various measuring instruments used for the measurement of dimensions and geometrical properties. The course covers the design and working of the measuring instruments which are used for measurements of other physical properties such as temperature, pressure etc. and quantities such as force, strain, speed etc. The course also covers the study of various standards, limit gauges as well as comparators.

Course Prerequisite:

Student shall have knowledge of function of machine elements such as gears, levers etc. and of simple mechanisms. A sound background of fundamental laws and principles related to different properties such as pressure, temperature etc. and quantities such as force, stress, strain etc. is essential.

Course Objectives: During this course, student is expected

1. To study the principles, construction and working of various measuring instruments used for measurement of various mechanical properties such as geometrical, dimensional, pressure, temperature etc and of parameters such as force, strain etc.
2. To study the concepts related to interchangeability, limits, fits, guidelines by BIS and design of limit gauges.
3. To learn the use of various measuring instruments with different setups for accurate measurements.
4. To get acquainted with various standards of measurements & the calibration process of instruments.

Course Outcomes: At the end of this course,

1. Students will understand the design & construction of measuring instruments.
2. Students will setup the Instruments & accessories for measurement of properties by avoiding errors.
3. Students will calibrate the simple instruments using more accurate standards.
4. Students will use the instruments for various industrial applications such as quality control, process control etc

Section I

Unit 1. Introduction: Principles and Standards of measurement No of lectures – 05

• **Prerequisite:** Knowledge of basic principles from the subjects of Physics, Theory of Machines and machine drawing.

• **Objectives:**

1. To get acquainted with various standards of measurements.
2. To Study the principles of simple length measuring instruments.

• **Outcomes:** After completing this unit, student will

1. Use the length measuring instruments.
2. Calibrate the simple instruments using more accurate standards.

• **Unit Content:**

Concept and need of measurement. Precision and accuracy. Classification of standards, International standards of length. Line, End & Wave length standards, Slip gauges, Slip-gauge sets (M-45, M-87). Selection of slip gauges including numerical problems. Measuring principles of Vernier caliper & micrometer.

• **Content Delivery Methods:** Board, Chalk and talk

Unit 2. Systems of Limits and Fits and Limit Gauging: No of lectures – 05

Prerequisite: Knowledge of manufacturing processes, machine drawing.

• **Objectives:**

1. To study the concepts related to interchangeability, limits, fits, guidelines by BIS and design of limit gauges.

• **Outcomes:** After completing this unit, student will

1. Use IS 919 for identifying the tolerances and limit deviations as well as for selection of fits.
2. Design limit gauges for simple hole and shaft components.

• **Unit Content:**

Terminology, Interchangeability, Types of tolerances, Types of fits, Grades of tolerances and types of fundamental deviations. Hole and shaft basis systems. Use of BIS charts (IS 919) specifying fundamental deviations and tolerances. Taylor's Principles of gauge design, types of gauges, Design of limit gauges, gauge tolerance & wear allowance, (numerical problems).

• **Content Delivery Methods:** Board, Chalk and talk

Unit 3. Comparators & angular measurements: No of lectures – 05

• **Prerequisite:** Knowledge of function of basic machine elements and mechanisms, Basic principles from Geometry and Physics.

• **Objectives:**

1. To Study the principles, construction and use of comparators and angle measuring instruments.

• **Outcomes:** After completing this unit, student will

1. Describe the design & construction of comparators and angle measuring instruments.

2. Setup the Instruments & accessories for measurement of properties by avoiding errors.

- **Unit Content:**

Introduction to comparators, Characteristics, Classification of comparators. Mechanical comparators – Johanson Mikrokator, Sigma comparator, dial indicators. Pneumatic comparators, Principle of optical comparators. Angular Measurements - Spirit level, Clinometers, Bevel Protractor, Principle & use of Sine Bars, Sine Centre, Use of angle gauges (Numerical on Building of angles) Autocollimator.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 4. Screw-Threads, Gear Metrology & Recent trends in measurement: No of lectures – 05

- **Prerequisite:** Knowledge of machine elements such as screw threads and gears and of principles from Theory of Machines, Geometry.
- **Objectives:**
  1. To Study the principles, construction and use of Instruments used for measurement of Screw thread diameters and gear tooth thickness.
  2. To get acquainted to latest trends in the mechanical measurements.
- **Outcomes:** After completing this unit, student will
  1. Describe the design &construction measuring instruments used for screw thread and gear tooth measurement.
  2. Setup the above instruments & accessories for measurement of properties by avoiding errors.
- **Unit Content:**

Basic elements of screw-thread, Methods of measurement of effective diameter, floating carriage Micrometer. Basic elements of spur-gear, Methods of measurement of gear tooth thickness. Introduction to modern measurement techniques- Co-ordinate Measuring Machine, laser Measurement, Multi Gauging Systems.

- **Content Delivery Methods:** Board, Chalk and talk

Section - II

Unit 5. Introduction to Mechanical Measurements: No of lectures – 05

- **Prerequisite:** Knowledge of basic principles in Physics, Analysis of mechanical elements and basic electrical engineering.
- **Objectives:**
  1. To learn the working of generalized measurement system and of the functional elements in it.
  2. To know the static and dynamic terms and characteristics of general measuring instruments.
- **Outcomes:** After completing this unit, student will
  1. Describe the working of the general measuring system and role of functional units.
  2. Explain the effect of different characteristics on the performance of the instrument.

• **Unit Content:**

Need of Mechanical Measurement, Instruments, Measurement methods, generalized measurement system & its functional elements. Instrument characteristics - Static & Dynamic characteristics and terms, calibration. Classification of transducers.

• **Content Delivery Methods:** Board, Chalk and talk

Unit 6. Measurement of Temperature and Pressure: No of lectures – 05

• **Prerequisite:** Knowledge of basic principles of thermodynamics, fluid mechanics, machine elements and theory of machines.

• **Objectives:**

1. To acquire the knowledge of principle, construction and use of various instruments used for measurement of temperature and pressure.

• **Outcomes:** After completing this unit, student will

1. Explain the working of various temperature and pressure measuring instruments.
2. Setup the instruments and accessories thereof for accurate measurement.

• **Unit Content:**

Importance of temperature measurement, Thermometer, Thermocouple - Principle, Types. Resistance Thermometers - RTD, Thermistor. Importance of pressure & vacuum measurement, Range of high pressure & vacuum Bourdon tubes, Deadweight pressure-gauge tester, Diaphragm gauge, Piezo-electrical pressure gauge, Vacuum gauges - McLeod gauge, Pirani gauge.

• **Content Delivery Methods:** Board, Chalk and talk

Unit 7. Measurement of angular speed & flow: No of lectures – 05

• **Prerequisite:** Knowledge of basic principles of fluid mechanics, machine elements, theory of machines and basic electrical engineering.

• **Objectives:**

1. To acquire knowledge of principle, construction and use of various instruments used for measurement of angular speed and flow rate.

• **Outcomes:** After completing this unit, student will

1. Explain the working of various speed and flow rate measuring instruments.
2. Setup the instruments and accessories thereof for accurate measurement.

• **Unit Content:**

Importance of angular speed measurement, Mechanical tachometers, Electrical tachometers-Drag cup, Inductive, Photoelectric pickup, Stroboscope. Importance of Flow measurement, Turbine meter, Rota meter, Gas flow meter, Hot wire anemometer.

• **Content Delivery Methods:** Board, Chalk and talk

Unit 8. Measurement of Force, Torque & Strain: No of lectures – 05

• **Prerequisite:** Knowledge of machine elements, mechanics, basic electrical engineering, fluid mechanics.

- **Objectives:**
    1. To acquire knowledge of principle, construction and use of various instruments used for measurement of force, torque and strain.
- **Outcomes:** After completing this unit, student will
    1. Explain the working of various force, torque and strain measuring instruments.
    2. Setup the instruments and accessories thereof for accurate measurement.
- **Unit Content:**

Force measurement- Balance, Proving Ring, Hydraulic, Pneumatic Load Cells, Torque measurement - Hydraulic, Eddy Current. Classification of strain gauges, Principle of electrical strain gauge, Gauge factor, Introduction to half bridge and full bridge network circuits.

- **Content Delivery Methods:** Board, Chalk and talk
- **TERMWORK**

A) Metrology Laboratory:

Any five of the following experiments (Experiment No. 1 is compulsory).

1. Uses of various length measuring instruments .Vernier instruments, Micrometer instruments, Dial instruments and Auxiliary instruments for carrying out measurements.
2. Calibration of Vernier caliper / Micrometer using slip gauges.
3. Use of at least one type of each class of comparator such as mechanical, optical, pneumatic, etc.
4. Measurement of angle using Bevel protractor and sine bar / sine centre. Use of Clinometer and Angle gauges.
5. Measurement of Gear tooth thickness using gear tooth vernier caliper/ plate type micrometer
6. Measurement of diameters of screw threads using screw thread micrometer and floating carriage micrometer.
7. Demonstration of advanced measuring equipment such as Co-ordinate Measuring Machine Multigauging Machines, Automatic inspection systems. (May be done through Industrial Visits / Virtual Laboratories).

B) Mechanical Measurements Laboratory

Any five out of the following experiments:

1. Temperature Measurement using thermo couples, RTD, Thermistor.
2. Testing of mechanical pressure gauge using Dead Weight pressure tester.
3. Vacuum measurement using U tube manometer & Mechanical Vacuum Gauge.
4. Angular speed measurement using mechanical tachometer, stroboscope, photo electric pickup, inductive pickup.
5. Flow measurement using Rotameter.
6. Measurement of bending strain or load using strain gauges.
7. Use of proving ring, load cells.
8. Measurement of torque.

* Industrial Visit (Recommended for introduction to modern measuring instruments / Calibration Lab)

Text Books:

1. Engineering Metrology: I.C. Gupta
2. Mechanical Measurement & Control: Dr.D.S. Kumar
3. A Text Book Metrology (including Mechanical Measurements): M. Mahajan

Reference Books:

1. Practical Engineering Metrology: Sharp KWB, Pitman, London.
2. Engineering Metrology: R.K.Jain, Khanna Publishers.
3. Mechanical Measurement: Sohni& Dr. Radhakrikshan.
4. Mechanical Measurement: Beckwith, Buck, Ro

Solapur University Solapur
T.E. (Mechanical Engineering) Part-I
ME313 METALLURGY

Teaching Scheme:
Lectures: 3hrs / week

Practical: 2 hrs./ week/ batch

Examination Scheme:
ESE: 70Marks
ISE: 30 Marks
ICA: 25Marks
Oral Exam: 25Marks

- **Course Introduction**:
  Metallurgy is an art of extracting the pure metals from its ore. Its full scope is in:
  a. Mixing two or more metals to form an Alloy.
  b. Shaping the metals & alloys by different processes such as Casting, Forming, and Joining etc.
  c. Undergoing suitable Heat treatment for modifying the properties.
  d. And finally, in Inspecting & testing before putting the products in to use.

- **Course Prerequisites:** Engineering Chemistry, Work shop practices, Manufacturing processes.
- **Course Objectives:** To make the students proficient in:
  1. Structures, composition, properties, applications of materials and their selection for design purpose.
  2. Testing of materials and its significance.
  3. Heat treatment processes for different engineering materials.
  4. Powder metallurgy process and composite materials with its applications.

- **Course Outcomes:** At the end of course, students will be able to;
  1. Demonstrate relevance of principles of physical Metallurgy and its significance.
  2. Apply knowledge regarding selection of ferrous materials for engineering applications.
  3. Get acquainted with various Non-ferrous alloys & advanced materials for selection & applications.
  4. Demonstrate the significance of heat treatment processes and their applications in the field of Automotive and Machine tool industries
  5. Apply their knowledge regarding selection of suitable testing method for identifying the suitable mechanical properties.
  6. Understand the significance of Powder metallurgy for manufacturing of products.

Section - I

Unit 1- Fundamentals of metallic materials **No of lectures – 04**

- **Prerequisites:** Concept of metals , Phase rule from Engineering Chemistry
- **Objectives:** i. To classify different metallic materials
  ii. To understand concept of alloying & equilibrium diagrams.
- **Outcomes:** At the end of chapter, students will be able to
  i. Understand the concept of alloying
  ii. Classify different metallic materials & equilibrium diagrams
- **Contents of Chapter:**
  a) Brief classification of Metals

b) Concept of alloying, classification of cooling curves, types of equilibrium diagram.
c) Introduction to solid solution, types (in brief)

- **Delivery method:** Board & chalk
-

Unit 2- Study of Ferrous materials & alloys **No of lectures – 10**

- **Prerequisites:** Concept of metals &non metals, ferrous and non ferrous alloys
- **Objectives:** i. To study phases, temperatures & transformations in Fe-Fe_3C Equilibrium diagram.
  ii. To classify different steels & cast irons with respect to its Properties & applications.
- **Outcomes:** At the end of chapter, students will be able to
  i. Explain different types of steels & cast irons with respect to their microstructures, properties & applications.
  ii. Explain different standards & specifications of steels, cast irons.
- **Contents of chapter:**
  i. Iron-Iron carbide equilibrium diagram.
  ii. Plain carbon steels, composition, applications & properties.
  iii. Effect of alloying elements on steels
  iv. Study of some important alloy steels & their applications
    a. General purpose steels such as : Hadfield Steel, Ni-Cr Steel, Free cutting steel, HSLA, Steel, Marageing steel, Dual Phase steel, Invar steel.
    b. Tool steels: Cold worked tool steels, Hot worked tool steels, High speed steels &Special purpose tool steels.
    c. Stainless steels: Martensitic, Ferritic&Austentic.
  v. Introduction to Specifications & Standards used for steels.
  vi. **Cast irons:** Composition, properties, applications & comparisons of various types of cast irons. i.e. White iron, Gray iron, SG iron, Malleable iron, alloy cast irons, patented CI like Mehanite.
- **Delivery method:** Board & chalk

Unit 3- Study of nonferrous metals & alloys
No of lectures – 06

- **Prerequisites:** Concept of metals &nonmetals, ferrous and nonferrous alloys.
- **Objectives:** i. To classify different nonferrous metals & alloys
  ii. To understand properties & applications of various nonferrous alloys.
- **Outcomes:** At the end of chapter, students will be able to
  i. Explain properties & applications of various nonferrous alloys.
  ii. Understand the concept of composite materials &nano materials.
- **Contents of chapter:**
  a. Copper alloys, brasses, bronzes.
  b. Aluminum alloys: Al-Si alloy, Al-Cu alloy and steps in precipitation hardening.
  c. Lead –Tin alloys: Study of solder materials, Babbitt. Introduction to fusible alloys.
  d. Introduction to Composite materials & Nano materials.
- **Delivery method**: Board & chalk

Section -II

Unit 4 - Heat treatments of steels **No of lectures – 10**

Prerequisites: Concept of solidification, heat removal during cooling, knowledge about basic manufacturing processes, basic applications of metals & alloys in day today's life

- **Objectives:** i. To classify different Heat treatment processes
  ii. To understand the significance of various heat treatment processes of steel.
- **Contents of chapter:**

  a. Heat treatment definition, concept, objectives. Introduction to isothermal transformation & TTT diagram for eutectoid Steel. Transformation on continuous cooling, critical cooling rate.

  b. Annealing & normalizing- definitions, purposes, types of Annealing, applications and comparisons.

  c. Hardening & Tempering: definition ,process, applications quenching media, Methods of hardening such as Austempering, Martempering, Concept of Harden ability in brief, objectives & types of Tempering, Subzero treatment.

  d. Surface hardening treatments /Case hardening (Application oriented)

  i. Flame hardening & Induction hardening

  ii. Carburizing, Nitriding, Cyaniding, &Carbonitriding.
- **Delivery method**: Board & chalk

Unit 5 - Mechanical Testing of Metals **No of lectures – 06**

- **Prerequisites:** Concept of stress-strain, deformation, properties of metals & alloys
- **Objectives:** i. To classify different types of Destructive &Non destructive testing.
  ii. To explain the use of these tests for particular application.
- **Outcomes:** At the end of chapter, students will be able to
  i. Demonstrate the method for carrying out any mechanical test.
  ii. Select the suitable Destructive test & NDT for particular application.
- **Contents of chapter:**

  a. Destructive testing methods, test procedure in brief, significance of i) Tensile testing ii) Hardness testing iii) Impact testing iv) Creep v) Fatigue testing.

  b.Study of Non Destructive Testing methods (NDT) such as i) dye penetrant test ii) magnetic Particle test iii) Ultrasonic test iv) Radiography test v) Eddy current test.
- **Delivery method**: Board & chalk

Unit6-Introduction to Powder Metallurgy **No of lectures – 04**

- **Prerequisites:** Concept of solubility, diffusion, basic manufacturing processes, properties of metals & alloys.
- **Objectives:** i. To study the principle of Powder Metallurgy.
  ii. To explain the applications of powder metallurgy in the industries.
- **Outcomes:** At the end of chapter, students will be able to
  i. Explain various applications & steps in Powder Metallurgy.
  ii. Explain the procedure for manufacturing of mechanical component from metal/non metal powders.
- **Contents of chapter:**

  a) Applications of Powder Metallurgy.

  b)Significance, Methods of powder manufacture, mixing / blending, compaction methods, sintering processes & its significance, advantages & limitations.

c) Typical powder metallurgy applications and their flow chart: - Self lubricated bearings, cemented carbide cutting tools, friction materials, etc

- **Delivery method**: Board & chalk

- **Term work**

Any Eight experiments out of the following:

1. Study of metallurgical microscopes & specimen preparation for microstructure observations.
2. Study of microstructures of Steels.
3. Study of microstructures of Cast irons.
4. Study of microstructures of Nonferrous alloys
5. Demonstration of Macro examination such as Spark test.
6. Study and demonstration of Heat treatment processes.
7. Study and demonstration of Tensile, Impact, and Hardness tests.
8. Study and demonstration of any of the NDT processes.
9. Study of grain size measurement.
10. Study of Microstructures of Annealed, Normalized, Hardened& Tempered samples.
11. Study of microstructures of Case hardened samples & Powder metallurgical components.

Note: 1. Content delivery during lectures &practical should be Application oriented.

2. Paper setting shall be based on Theory Syllabus and ICA.

- **Recommended Books:**
  - **Text Books**

1. Material Science and Metallurgy – Dr. Kodgire (Everest, Pune).
2. Engineering Metallurgy I & II – A. S. Gholap& M. S. Kulkarni
3. Introduction to Engg. Materials – B. K. Agarwal (TMH).

  - **Reference Books**

1. Heat treatment principles and technique - Rajan Sharma & Sharma
2. Introduction to Physical metallurgy – Avner, TMH.
3. Engineering Metallurgy Vol. I & II – R. A. Higgins (ELBS).
4. Engineering Metallurgy – E. C. Rollason (ELBS)
5. Engineering Metallurgy - Lakthin (MIR Publishers).

Solapur University, Solapur

T.E. (Mechanical Engineering) Semester-I

ME314 Machine Design-I

Teaching Scheme	Examination Scheme
Lectures– 3 Hours/week, 3 Credits	ESE– 70 Marks
Tutorial – 2 Hour/week, 1 Credit	ISE –30 Marks
	ICA- 25 Marks

- **Course Introduction:**

This course seeks to provide an introduction to machine design and discusses various procedures, requirements, design methods. It introduces engineering materials and describes the different kinds of irons, steels and alloys used in engineering design with IS Codes. A further content explains in detail the manufacturing considerations in design. Components design procedures for design against static load and fluctuating load is also covered in content of the course. The features and varieties of threaded joints, and welded and riveted joints are explained with design considerations. Similarly design of shafts and keys with IS codes, design of couplings; springs and selection of belt drives from manufacturers catalogue is explained in detail.

- **Course Prerequisite:**

Student shall have knowledge of function of machine elements such as keys, couplings, pulleys, joints etc. A sound background of analysis of mechanical element is essential for successful completion of this course.

- **Course Objectives:** During this course, student is expected

i. To work on selecting proper material for mechanical components.
ii. To study design process.
iii. To carry out design of Mechanical Components such as springs, shafts.
iv. To conduct analysis of temporary and permanent joints
v. To carry out estimation of endurance strength and calculation of the fatigue life of the mechanical component.
vi. To practice the standardization in design of machine elements.

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

i. Select the proper material for mechanical components
ii. Explain Design Process.
iii. Design Mechanical Components such as joints, springs, shafts.
iv. Analyze temporary and permanent joints
v. Estimate the fatigue life of the mechanical component.
vi. Implement standardization in design of machine elements.

Section I

Unit 1–Fundamentals of machine design. **No of lectures – 03**

- **Prerequisite:** Knowledge of analysis of mechanical elements and machine drawing.
- **Objectives:**
  1. To work on selecting proper material for mechanical components.
  2. To study design process.

- **Outcomes:** After completing this unit, student will be able to
    1. Explain/Apply Design Process
    2. Select the proper material for mechanical components
- **Unit Content:**

Procedure of machine design, , Types of loads, Factor of safety- its selection and significance, Theories of elastic failure and their applications, selection of preferred sizes. (No Numerical treatment)

- **Content Delivery Methods:** Board, Chalk and talk

Unit 2– Design of simple machine parts against static load No of lectures – 06

- **Prerequisite:** Knowledge of analysis of mechanical elements, machine drawing, material selection and factor of safety.
- **Objectives:**
    1. To carry out design of cotter joint, knuckle joint, turn buckle and levers.
- **Outcomes:** After completing this unit, student will be able to design.
    1. Cotter joint, knuckle joint, turn buckle and levers.
- **Unit Content:**

Socket and Spigot Cotter joint, knuckle joint, levers (lever loaded safety valve and right angled bell crank lever) (Numerical treatment).

- **Content Delivery Methods:** Board, Chalk and talk

Unit 3– Design against fluctuating loads No of lectures – 06

- **Prerequisite:** Design of machine elements against static load
- **Objectives:**
    1. To carry out estimation of endurance strength for a component under completely reversed load
    2. To carry out estimation of endurance strength for a component under fluctuating load
- **Outcomes:** After completing this unit, student will be able to
    1. Calculate endurance strength of a component subjected to completely reversed load
    2. Calculate endurance strength of a component subjected to completely fluctuating load
- **Unit Content:**

Stress concentration causes and remedies, fatigue failure, endurance limit, notch sensitivity, Goodman and Soderberg diagram, modified Goodman diagram, design for finite and infinite life under reversed and fluctuating stresses. (Numerical Treatment).

- **Content Delivery Methods:** Board, Chalk and talk

Unit 4– Selection of Belt. No of lectures – 05

- **Prerequisite:** Concepts of velocity ratio, types of belts, calculation of belt length.
- **Objectives:**
    1. To refer manufacturer's catalogue for selection of Flat Belt.
    2. To refer manufacturer's catalogue for selection of V- Belt.
- **Outcomes:** After completing this unit, student -
    3. Select Flat Belt from manufacturer's catalogue.
    4. Select V- Belt from manufacturer's catalogue.
- **Unit Content:**

Selection of flat and V belt from standard manufacturers' catalogue/Design data book. (Numerical Treatment)

- **Content Delivery Methods:** Board, Chalk and talk

Section II

Unit 5–Manufacturing Considerations Design **No of lectures – 03**

- **Prerequisite:** Knowledge of manufacturing processes and assembly of simple machine components.
- **Objectives:**
    1. To learn standard design principles for Manufacture, casting, forging, machining, assembly.
- **Outcomes:**

After completing this unit, student will be able to

1. Incorporate the standard design principles for Manufacture, casting, forging, machining and assembly.

- **Unit Content:**

Design considerations for casting, Design considerations for forging, Design considerations for machined parts, Design for manufacture and assembly.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 6– Design of shafts, keys and couplings. **No of lectures – 06**

- **Prerequisite:** Knowledge of analysis of mechanical elements and mechanics.
- **Objectives:**
    1. To learn ASME codes for shaft design
    2. To design hollow and solid shafts
    3. To write design equations for key.
    4. To write design equations for muff, rigid flange and flexible bush pin type coupling
- **Outcomes:** After completing this unit, student will be able to
    1. Use ASME codes for shaft design
    2. Design hollow and solid shafts
    3. Design keys.
    4. Design equations for muff, rigid flange and flexible bush pin type coupling
- **Unit Content:**

Materials for shaft, Design of solid and hollow shaft on strength basis (maximum principal stress theory and Maximum shear stress theory) and on basis of torsional rigidity . ASME code for shaft design. Design of square and flat keys. Splined shaft (Introductory treatment). Types of couplings- Muff, rigid flange and flexible bush pin type coupling. (Numerical treatment excluding Splined shaft)

- **Content Delivery Methods:** Board, Chalk and talk

Unit 7 – Design of springs. **No of lectures – 05**

- **Prerequisite:** Design against static load, shaft design for torsional strength.
- **Objectives:**
    1. To obtain equation for deflection of a helical compression spring.
    2. To obtain equation for shear stress in a helical compression spring.
    3. To obtain equation for springs in series and springs in parallel.
- **Outcomes:** After completing this unit, student will be able to
    1. Design a helical compression spring for required deflection/load.
    2. Calculate equivalent stiffness for springs connected in series and parallel.

- **Unit Content:**

Types of springs and their applications, terminology of helical spring, styles of end, spring materials, stress and deflection in helical spring, series and parallel springs. Introduction to leaf springs. (Numerical treatment excluding leaf spring)

- **Content Delivery Methods:** Board, Chalk and talk

Unit 8– Design of Joints **No of lectures – 06**

- **Prerequisite: Knowledge of analysis of mechanical elements and mechanics.**
- **Objectives:**
    1. To develop strength equations for bolted joints
    2. To develop strength equations for riveted joints
    3. To develop strength equations for welded joints
- **Outcomes:** After completing this unit, student will be able to
    1. To design bolted joints
    2. To design riveted joints
    3. To design welded joints
- **Unit Content:**

Bolted joint- Simple analysis, eccentrically loaded bolted joint in shear, eccentric load perpendicular to axis of bolt. (Numerical limited to static loading).

Welded Joints- Strength of butt welds, transverse fillet welds, axially loaded unsymmetrical lap joint, eccentrically loaded welded joint in shear (Numerical treatment).

Riveted joints- Types of failure and strength equations (Introductory treatment)

- **Content Delivery Methods:** Board, Chalk and talk

Term Work:

Part A: Assignment based on the following.

a) Selection of materials for various engineering applications showing their IS codes, composition and properties
b) Eccentric axial loading- design of hacksaw frame- offset link.
c) Problems on design of helical springs subjected to static load.
d) Problems on bolted and welded joints.
e) Problems on design of shaft using ASME codes.

Part B: Design and drawing of Turn buckle.

- **Text Books:**

1) "Design of Machine Elements", V.B. Bhandari, 4th edition, McGraw Hill.PSG Design data Book.

- **Reference Books:**

1) Design of Machine Element by J.F. Shigley, McGraw Hill Publications
2) Design of Machine Element by M.F.Spotts, Pearson Education Publication

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-I
Professional Elective-III Course I
ME315 Machine Tool Design

Teaching Scheme	Examination Scheme
Lectures– 3 Hours/week, 3 Credits	ESE– 70 Marks
Practical – 2 Hour/week, 1 Credit	ISE –30 Marks
	ICA-25 Marks

- **Course Introduction**

A study of machining practices with machine tool design which comprises the analysis, design, construction and application of tools, methods and procedures necessary to increase manufacturing productivity.

- **Course Prerequisite**

Student shall have knowledge of Applied Physics, Engineering Mathematics, Analysis of mechanical elements, basics of control engineering and Mechanical Vibration, also sound background of Machine Design is essential for successful completion of this course**.**

- **Course Objectives**

1. To study machine tools types and general principle of design, and recent trends.
2. To make student familiar with machine tool drives its classification, working and design.
3. To learn design of machine tool structure, guide ways, slide-ways and column.
4. To analyze the dynamics of machine tool and control system in machine tool.
5. To enhance productivity by implementation of advanced machine Tools and Controls.

- **Course Outcomes**

1. To demonstrate principle of machine tool design.
2. To design machine tool structure, guide ways, slide-ways and column.
3. To select machine tool drives, design calculations for spindle, bearing.
4. To do dynamic analysis of machine tools and control systems.
5. To select suitable advanced machine tools and controls to enhance productivity.

Section I

Unit 1–General Principles of Machine Tool Design **No of lectures – 05**

- **Prerequisite:** Knowledge of Applied Physics, Analysis of mechanical elements and Engineering Mathematics
- **Objectives:**
    1. To study machine tools types and general principle of design, and recent trends.
    2. To make student familiar with machine tool classification, working and motion.
- **Outcomes:** After completing this unit, student will be able to
    1. To demonstrate principle of machine tool design.
    2. Familiar with machine tool classification, working and motion.

- **Unit Content:**

Classification of machine tools, General requirements of machine tool design, Engineering design process applied to machine tools, Layout of machine tools, working and auxiliary motions in machine tools.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 2–Design of Machine Tool Drives **No of lectures – 05**

- **Prerequisite:** Knowledge of Applied Physics and analysis of mechanical elements, and Engineering Mathematics.
- **Objectives:**
    1. To make student familiar with machine tool drives
    2. To study effect of speed and feed for design calculations.
- **Outcomes:**

1. To select machine tool drives, design calculations speed and feed.

- **Unit Content:**

Types of Speed and feed regulation, Classification of speed and feed boxes, Design of feed box, Speed box, Development of gearing diagram.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 3–Design of Machine Tool Structures
No of lectures – 05

- **Prerequisite:** Knowledge of Material Sciences.
    - **Objectives:**
    1. To learn design of machine tool structure, and column.
- **Outcomes:** After completing this unit, student will be able to
    1. To design machine tool structure, and column.
- **Unit Content:**

Functional requirements of machine tool structures, Design criteria & procedure for machine tool structures, Materials for machine tool structures, Design of beds, columns and housings and other parts of machine tools, Method to improve the stiffness and rigidity of structure, Overall compliance of machine tool.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 4–Design of Guide ways
No of lectures – 05

- **Prerequisite:** Knowledge of Engineering Mathematics, Friction and machine Design.
- **Objectives:**
    1. To learn design of guide ways and slide-ways.
- **Outcomes:** After completing this unit, student -
    1. To design guide ways and slide-ways.

- **Unit Content:**

Functions and types of Guide ways, Design of slide-ways, Design criteria and calculations for slide-ways, Guide ways operating under liquid friction conditions, Design of Aerostatic slide-ways, Design of Antifriction slide-ways.

- **Content Delivery Methods:** Board, Chalk and talk

Section II

Unit 5–Design of Spindles and Spindle Supports **No of lectures – 05**

- **Prerequisite:** Knowledge of Materials, Measurement and metrology, Mathematics.
- **Objectives:**
    1. To learn function, requirements, design and materials for bearing and spindles.
- **Outcomes:** After completing this unit, student will be able to
    1. To design for spindle and bearing.
- **Unit Content:**

Functions of spindle unit and requirements, Materials, Machine tool compliance & machining accuracy, Design calculations of spindles, Bearings for spindles.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 6–Dynamics of Machine Tools **No of lectures – 05**

- **Prerequisite:** Concept of vibrations.
- **Objectives:**
    1. To analyze the dynamics of machine tool.
- **Outcomes:** After completing this unit, student will be able to
    1. To do dynamic analysis of machine tools.
- **Unit Content:**

Forced vibrations of machine tools, Dynamic characteristics of elements and systems, Stability analysis.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 7 –Control Systems in Machine Tools **No of lectures – 05**

- **Prerequisite:** Concept of Control Engineering and fundamentals of Ergonomics.
- **Objectives:**
    1. To study, functions and requirements of control system in machine tool.
    2. To study also Ergonomic aspects of design for machine tool control elements
- **Outcomes:** After completing this unit, student will be able to
    1. Select a suitable control system in machine tool considering Ergonomic aspects.
- **Unit Content:**

Functions, requirements and classification, Control systems for speeds and feeds, various motions etc. Manual & automatic control systems. Ergonomic aspects of design for machine tool control elements such as levers, hand-wheels, buttons etc.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 8–Trends and developments in machine tool design. No of lectures – 05

- **Prerequisite:** Knowledge of Advanced Manufacturing Processes
- **Objectives:**
    1. To enhance productivity by implementation of Advanced Machine Tools and Controls.
- **Outcomes:** After completing this unit, student will be able to
    1. To select suitable advanced machine tools and controls to enhance productivity.
- **Unit Content:**

Combined Multifunctional Machine Tools, High-Speed, High-Efficiency Machine Tools, Ultra precision Machine Tools and Advanced and Intelligent Control

- **Content Delivery Methods:** Board, Chalk and talk
- **Term work**

1 Any one problem on

(a) Design of a spur/helical gear box for machine tool - Report containing all calculations, Sketches for design of a typical gear box.

(b) Two sheet of A2 size containing drawing of details and assembly for a typical gear box as per (i)

2 Any two assignments on the following

(a) Selection of belts for a machine tool.

(b) Hydraulic system in a machine tool.

(c) Design of guide ways based on wear resistance and stiffness.

(d) Designing machine tool for leanness.

*Standard Design data books for all above experiments should be used.

- **Text Books:**

1 Machine tool design and numerical control by N.K.Mehta, Tata Mc- Graw Hill Publication

2 Design of Machine Tools by S.K.Basu, Oxford and IBH publishing, New Delhi

3 Principals of machine Tools by Sen. and Bhattacharya, New age central book agency.

- **Reference Books:**

1 Mechanical Vibration by G. K. Grover, Published by Nemchand& Brothers, Roorkee

2 Mechanical Vibrations by Dr. V. P. Singh, Published by S. Chand & Sons New Delhi.

3 Principals of machine Tools by Koenigs-Berger

4 Machine Design by T H WentzellCengage Learning

5 ANIL GUPTA and T K KUNDRA "A review of designing machine tool for leanness" sadhana - vol. 37, part 2, April 2012, pp.241-259. Publication. Indian academy of sciences. Available www.ias.ac.in/sadhana/Pdf2012Apr/241.pdf

6 Handbook of production technology by CMIT Bangluru.

7 http://www.ntnglobal.com/en/products/review/pdf/NTN_TR74_en_P002.pdf

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-I
Professional Elective-III Course-II
ME315 Material Handling System

Teaching Scheme	**Examination Scheme**
Lectures– 3 Hours/week, 3 Credits	**ESE– 70 Marks**
Practical – 2 Hour/week, 1 Credit	**ISE –30 Marks**
	ICA-25 Marks

- **Course Introduction:**
  This course provides introduction of material handling devices, various systems for material handling, material flow, selection of material handling devices, CIMS in its contents. Human and environmental safety is also covered in course.

- **Course Prerequisite:** Student should have knowledge of Production Processes, Production planning, inventory management, Automation in production process and basic safety and environmental activities is essential for successful completion of this course**.**

- **Course Objectives:** During this course, student is expected
  i. To study material handling equipment's.
  i. To design material handling System like storing, hoisting, and conveying equipment's.
  ii. To enhance knowledge in CIMS in material handling systems.
  iii. To make aware of safety regulations in material handling.

- **Course Outcomes:** At the end of this course, student will be able to
  i. To design and process material handling System like storing, hoisting, and conveying equipment's.
  ii. Implement CIMS in material handling systems.
  iii. Implement safety regulations in material handling.

Section I

Unit 1–Introduction to Material Handling **No of lectures – 05**

- **Prerequisite:** Knowledge of Material, Production and Mass production, Automation in production process.
- **Objectives:**
  1. To study the principles and Features of material handling system.
  2. To study characteristics and classification of material.
  3. To study unit load concepts.
- **Outcomes:** After completing this unit, student will be able to
  1. Able to apply the principle of material handling
  2. Able to select the right material.
  3. Understand the concept of unit load for applying.

- **Unit Content:**

  Principles and features of material handling system, importance, terminology, objectives and benefits of better material handling, Characteristics and classification of material , unit load Concepts.
- **Content Delivery Methods:** Board, Chalk and talk, PPT.

Unit 2–Material handling Equipment's and Systems for Various Materials No of lect. – 12

- **Prerequisite:** Knowledge introduction of material handling, basic mechanical engineering, theory of machines and production process.
- **Objectives:**
  1. To study Basic types of material handling Equipment.
  2. To Study Factors affecting for selection of material.
  3. To Design the Material Handling Equipment's.
- **Outcomes:** After completing this unit, student will be able to analysis
  1. Able to select material Handling Equipment.
- **Unit Content:**

  Basic Equipment Types, Classification of Handling Equipment, Storing equipment's, Hoisting equipment's, Conveying equipment's, Mobile equipment's, factors affecting for selection Material handling Equipment.
- **Content Delivery Methods:** Board, PPT, Chalk and talk**.**
-

Section II

Unit 3–Material Handling in CIMS No of lectures – 04

- **Prerequisite:** Knowledge of automation in production processes, CNC machine operations, advanced manufacturing process.
- **Objectives:**
  1. To Study CIMS.
  2. To Study Robotic Handling and Automatically guided vehicles
- **Outcomes:** After completing this unit, student will be able to
  1. Understand robots and its classification with their application.
  2. Understand the concept and Need of CIMS.
- **Unit Content:**

  Introduction of CIMS , Need of CIMS ,Difference between CIMS and conventional systems, Flexible Manufacturing System , Variable Mission Manufacturing , Computerized Manufacturing, Robotic Handling and automatically guided vehicles.
- **Content Delivery Methods:** Board, PPT, Chalk and talk

Unit 4–Material Flow No of lectures – 04

- **Prerequisite:** Knowledge of Basics of Production planning and Control, inventory management.

- **Objectives:**
    1. To study Material Flow Pattern.
    2. To study Operation Sequence.
- **Outcomes:** After completing this unit, student -
    1. Understand the material flow pattern and Operation sequence.
- **Unit Content:**

Operation sequence, material flow pattern, stages of material flow at receiving in process and at shipping

- **Content Delivery Methods:** Board, videos, PPT ,Chalk and talk

Unit 5–Selection of Material Handling Equipment **No of lectures – 12**

- **Prerequisite:** Knowledge of various material handling devices, Foundry, sugar manufacturing process.
- **Objectives:**
    1. To study factors affecting for selection of Material handling Equipment.
    2. To study analysis procedure and analytical techniques of material handling equipment.
    3. To study selection of material equipment for Green Sand molding foundry and Sugar Manufacturing Industry.
- **Outcomes:** After completing this unit, student will be able to
    1. Understand the factors affecting for selection of Material handling Equipment.
    2. Able to select the material equipment for Green Sand molding foundry and Sugar Manufacturing Industry.
- **Unit Content:**

Choice of material handling equipment, factors affecting for selection, general analysis procedures, basic analytical techniques, Material Handling Equation, Selection of Material Handling Equipment in Green Sand Molding Foundry, Sugar Manufacturing Industry

- **Content Delivery Methods:** Board, PPT, Chalk and talk

Unit 6–Safety & Training **No of lectures – 03**

- **Prerequisite:** knowledge of basic safety and environmental activities.
- **Objectives:**
    1. To study Environmental and human factors in material handling
    2. To study Safety Regulations and discipline.
- **Outcomes:** After completing this unit, student will be able to
    1. Understand environmental and human factors in material handling
    2. Understand the concept of Safety regulations and discipline.
- **Unit Content:** Need of Safety, Environmental and human factors in material handling, Safety Regulations and discipline
- **Content Delivery Methods:** Board, Chalk and talk

- **Term Work:**
    i. Plant layout consideration
    ii. Storing equipment
    iii. Conveyor equipment
    iv. Selection of M.H. equipment & safety aspects
    v. Material flow analysis
    vi. Hoisting equipment
    vii. Mobile equipment
    viii. Industrial visits & its report.

- **Text Books:**
    1. Material Handling - Immer J. R. (McGraw Hill)
    2. Material Handling System Design - James Apple ((John Wiley)
    3. Material Handling Principles & Practice - Theodore H. Allegre Sr. (CBS Publishers & Distributors

- **Reference Books:**
    1. Plant Layout & Material Handling - James Apple (John Wiley)
    2. Material Handling- John R. Immer- McGraw Hill Co. Ltd., New York
    3. Work Study - O. P. Khanna (Dhanpatrai& Sons)
    4. Work Study – I. L. O.

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-I
Professional Elective-III Course -III
ME315 Fluid Machinery & Fluid Power

Teaching Scheme
Lectures– 3 Hours/week,
Practical – 2 Hour/week,

Examination Scheme
ESE–70Marks
ISE-30 Marks
ICA – 25Marks

- **Course Introduction:**

This course seeks to provide an introduction to Fluid Machinery like water turbine, gas turbine, centrifugal pump and Fluid Power like hydraulic, pneumatic etc and discusses various procedures, requirements, design methods. A turbine design procedure against various head is also covered in content of the course. A further content explains in detail the various efficiency improving methods of open cycle gas turbine. It introduces various hydraulic and pneumatic elements for building various circuits according to the application. The features and varieties of hydraulic and pneumatic accessories is also covered in the course.

- **Course Prerequisite:**

Students shall have introductory knowledge of Water Turbines, Pumps, Gas Turbines and Various thermodynamic processes, laws of motion, material science etc is essential for successful completion of this course. A sound knowledge of vector algebra, fluid mechanics is essential for the study of this subject.

- **Course objectives:**
  1. To study different types of Water turbines, Gas turbines and Pumps, in details.
  2. To construct velocity triangles for turbines and pumps.
  3. To learn the fundamentals and applications of fluid power technology, besides construction & working of different components.
  4. To design various types of hydraulic & pneumatic circuits & their applications.
- **Course outcomes:** At the end of this course, the student will be able to
  1. Classify turbines and pumps. Select/design water turbines, gas turbines & centrifugal pumps to meet the specific requirements.
  2. Draw velocity triangles for turbines and pumps.
  3. Analyze different components of hydraulic and pneumatic systems.
  4. Construct different hydraulic & pneumatic circuits needed for different applications.

Section –I

Unit 1: Impulse Water Turbines **No of lectures – 05**

- **Prerequisite:** Introductory knowledge of roto dynamic machines, material science, fluid mechanics and vector calculations is essential.
- **Objectives:**
  1. Explain working principle of impulse turbines.
  2. To introduce conceptual Euler's Equation of rotod ynamic machines.
  3. To study the performance of a Pelton Wheel turbine
  4. To determine the characteristic curves of a Pelton turbine operating at a different fluid flow rates with high head.
- **Outcomes:**
  1. Student can calculate work done and various efficiencies of impulse turbines.
  2. Student will be able to understand different characteristics curves of impulse turbine due to the head available.
  3. Student will be able to calculate the performance of turbine based on Euler's equation for roto dynamic machines.
- **Unit Content:** Euler's equation for roto dynamic machines, Classification of water turbines, Pelton wheel, Work done and efficiencies of Pelton wheel, working proportions of Pelton wheel, Design of Pelton Turbine runner, governing of Pelton turbine, Performance characteristics of Pelton turbine. (Numerical Treatment)

i. **Content Delivery Methods:** Board, Chalk and talk, Animation Video

Unit 2: Reaction Water Turbines: **No of lectures – 05**

ii. **Prerequisite:** Introductory knowledge of roto dynamic machines, material science, fluid mechanics and vector calculations is essential.

iii. Objectives:

1. To introduce working principle of Francis & Kaplan Turbines.
2. To introduce Governing of Reaction Turbine
3. To introduce unit quantities & model testing
4. To introduce the concept of draft tube.

iv. Outcomes:

1. Understand the concept of unit quantities & model testing
2. Calculate the Work done & efficiency of reaction turbine
3. Understand the concept of Governing of reaction turbine

v. Unit Content:

Construction and Working of Francis, Kaplan turbine. Work done and efficiencies of Francis & Kaplan turbine, Working Proportions of Francis & Kaplan turbine, Specific speed of turbine (Pelton, Francis & Kaplan turbine), Model testing, unit quantities, Prediction of performance at other operating conditions, Draft tube (Theoretical treatment only), Types and function, governing of reaction turbines, Performance characteristics of Francis & Kaplan turbine. (Numerical Treatment).

vi. **Content Delivery Methods:** Board, Chalk and talk, Animation Video

Unit 3: Centrifugal Pumps **No of lectures – 05**

- **Prerequisite:** Knowledge of Centrifugal force, fluid mechanics, vector calculations, material science, etc. is essential.

vii. Objectives:

1. To make students to understand basics of working principle of centrifugal pump
2. To introduce constructional details of centrifugal pump
3. To make the students aware of Maximum Suction Height & Net Positive Suction Head
4. To introduce specific speed of pumps, Performance characteristics of pump

viii. Outcomes:

1. Understand working of centrifugal and multistage pumps.
2. Understand the concept of cavitations in pumps.
3. Calculate manometric head, work done and various efficiencies related to the Pump

ix. **Unit Content:** Working principle, construction, types, various Heads, multistage pumps, Velocity triangles, Minimum starting speed, Cavitations, Maximum Suction Height & Net Positive Suction Head, Methods of priming, Calculations of efficiencies, Discharge, blade angles, Heads, Power required, impeller dimensions, specific speed of pumps, Performance characteristics of pumps.
(Numerical Treatment)

x. Content Delivery Methods: Board, Chalk and talk

Unit 4: Gas Turbines **No of lectures – 05**

xi. **Prerequisite:** Knowledge of various thermodynamic processes, concept of thermal efficiency is essential.

xii. **Objectives:**

i. To introduce classification of gas turbine.
ii. To introduce various methods for improvements of thermal efficiency of open cycle gas turbine.
iii. To introduce the various gas turbine fuels.

- **Outcomes:**

i. Understand the classification of gas turbines.
ii. Understand the various methods for improvement of thermal efficiency of open cycle gas turbine.
iii. Student understands fuels used for gas turbine.

- **Unit Content:**

General aspects, Classification of gas turbines, merits of gas turbines, constant Pressure combustion gas turbines-open cycle gas turbine, methods for improvement of thermal efficiency of open cycle gas turbine plant-inter cooling, reheating, regeneration, effect of operating variables on thermal efficiency, closed cycle gas turbine, uses of gas turbine, gas turbine fuels.
(Numerical Treatment on basic Joule Cycle)

- **Content Delivery Methods:** Board, Chalk and talk

Section – II

Unit 5: Introduction to Fluid Power and Hydraulic System elements No of lectures – 05

- **Prerequisite:** Knowledge of Pumps and its types, material science, machine drawing, etc is necessary.

xiii. **Objectives:**

1. To Identify the various components used in Hydraulic System.
2. To Introduce the construction and working principle of various components used in Hydraulic System.
3. To Introduce the various symbols used in hydraulic and pneumatic system.
4. To calculate the force and velocity of piston.

- **Outcomes:**

1. Understand working principle of various components used in hydraulic system.
2. Understand the Accessories of hydraulic system.
3. Understand the various symbols and its meaning used in hydraulic and pneumatic system.
4. Calculate force and velocity of piston.

- **Unit Content:**

Types, advantages, applications of fluid power, Pumps- Types, working, Characteristics, Applications. Seals & Packing- Types, materials, Applications. Hydraulic Actuators- Linear &Rotary, Types, Working, Cushioning effects, Calculation of force & velocity of piston. System components: Accumulators, Intensifiers, their types, working, applications. Symbols used in hydraulic and pneumatic circuits.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 6: Pneumatic System Elements: No of lectures – 05

- **Prerequisite:** Knowledge of air compressor, fluid mechanics, force calculations, etc is necessary.
- **Objectives:**
  i. To introduce the construction and working principle of various components used in Pneumatic System.
  ii. To Introduce the various Accessories used in Pneumatic system.
- **Outcomes:**
  i. Understand working principle of various components used in Pneumatic system.
  ii. Understand the Accessories of pneumatic system
  iii. Student Get the importance of the Piping layout while building the circuit diagram.
- **Unit Content:**

Piping, materials and pressure ratings, piping layout, air compressors, types,working, selection criteria, FRL unit- construction and working, pneumatic cylinders and air motors, construction and working, types.

- **Content Delivery Methods:** Board, Chalk and talk

Unit7: Hydraulic and Pneumatic Control Elements **No of lectures – 05**

- **Prerequisite:** Knowledge of engineering drawing, properties of fluid used in Hydraulic & Pneumatic System.
- **Objectives:**
  i. To introduce the construction and working of various direction control valve used in hydraulic and pneumatic system.
  ii. To introduce the construction and working of various flow control valves and pressure control valves used in hydraulic and pneumatic system.
  iii. The selection of proper control valves for building the various circuit diagram.
- **Outcomes:**
  i. Understand working principle of various direction control valves used in hydraulic and pneumatic system.
  ii. Understand working principle of various flow control valves, pressure control valves used in hydraulic and Pneumatic system.
  iii. To differentiate the various control valves used in hydraulic and pneumatic system.
  iv. To choose proper control valves according to the applications/ circuits.
- **Unit Content:**

  Hydraulic - Pressure control valves- Direct acting type, pilot operated, sequence, Counter balancing, unloading, pressure reducing, Construction & Working. Direction control valves- Types, Construction & working, Spool actuation methods, spool centre positions, Flow control valves-Compensated& Non-Compensated, Construction & Working. Pneumatic-Direction control valves, Flow control valves and pressure control valves–types and working.
- **Content Delivery Methods:** Board, Chalk and talk

Unit 8: Hydraulic and Pneumatic Circuits & their applications: **No of lectures – 05**

- **Prerequisite:** Knowledge of various hydraulic and pneumatic systems, theory of machines is essential.
- **Objectives:**
  1. To introduce Speed control circuits
  2. To introduce Regenerative circuits
  3. To introduce Sequencing circuits
  4. To introduce Counter balancing, Synchronizing, circuits
- **Outcomes:**
  1. Understand the operation of hydraulic circuits and components typically used in industry
  2. Correctly maintain power units (fixed / variable pumps, reservoirs, filters, strainers and gauges)
  3. Use hydraulic test equipment to determine the nature and position of faults
  4. Construct a range of functional hydraulic circuits
- **Unit Content:**

  Speed control circuits, Regenerative, Sequencing, Counter balancing, synchronizing, Traverse & Feed circuit, Hydraulic and pneumatic clamping & braking systems, Pneumatic power tools, time delay circuits

- **Content Delivery Methods:** Board, Chalk and talk

Term-Work

Compulsory:

1. A drawing sheet on standard symbols of hydraulic & pneumatic components.

List of Experiments

A) Fluid Machinery-

Minimum 3 experiments from the following

1. Trial on a Pelton wheel.
2. Trial on a Francis/ Kaplan turbine.
3. Trial on a centrifugal pump.
4. Trial on gear pump

B) Fluid Power

Minimum 3 assignments from the following

5. Study of Pressure Control Valves & circuits using pressure control valves
6. Study of flow control valves & circuits using flow control valves
7. Study of direction control valves & check valves circuits.
8. Study of hydraulic power unit &accessories.
9. Demonstration of Minimum of Three hydraulic circuits such as :Basic hydraulic, Regenerative, Speed control (Meter in, meter out & bleed off), Sequencing, Synchronization, traverse & feed, Circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit, motor breaking circuit.
11. Demonstration on Pneumatic Trainer of Minimum of Three Pneumatic circuits (based on syllabus of UNIT 10above).

C) **Industrial visit to one of the following**

- Hydro-electric power station
- Pumping station
- Service station of Earth Moving equipment's.

Note: Students should write visit report based on the observations made during the visit.

- **Text Books**

1. "A text book of Fluid Mechanics & Hydraulic Machines", Dr.R.K. Bansal, Laxmi Publications Ltd.
2. Thermal Engineering R. K. Rajput
3. "Oil Hydraulics- Principle & Maintenance", Majumadar, Tata McGrawHill
4. "Pneumatics- Principle & Maintenance", Majumadar, Tata McGrawHill

- **Reference Books**

1. Theory of Hydraulic Machinery", V.P. Vasandani, Khanna Publishers, Delhi.
2. "Hydraulic Machines", Dr. J. Lal, Metropolitan Book Co. Pvt. Ltd., Delhi.
3. Vickers Manual on Industrial Hydraulics
4. Festo's Manual on Pneumatic Principle, applications
5. "ABC's of Hydraulic Circuits", H L Stewart, (Taraporwala Press)
6. "ABC's of Pneumatic Circuits", H L Stewart, (Taraporwala Press)
7. Hydraulics and Pneumatics'H.L.Stewart –, Industrial Press

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-I
6.0 Advanced Computer Programming – I
ME316 (JAVA Programming)

Teaching Scheme	**Examination Scheme**
Theory: 1 hour a week	**University Exam: Nil**
Practical: 2 hours a week	**ICA: 50 Marks**

- **Course Introduction:** This course emphasizes the fundamentals of various topics under Java Programming necessary for developing various scripts with respect to mechanical applications. Topics covered are Overview of Java, General Programming, OOP, Interface and packages, Arrays, Strings and Vectors, Debugging, Applets and Graphics.

- **Course Objectives:**
  1. To learn the basic syntax and semantics of JAVA
  2. To make students familiar with the general programming concepts of JAVA such as variables branching, loops and functions.
  3. To make the students learn and program JAVA scripts.
  4. Learn to make JAVA applets develop GUI based applications in JAVA.

- **Course Outcomes:** A student who has successfully completed this course must be able to accomplish the following tasks;
  1. Install JAVA IDE & develop simple applications using JAVA.
  2. Read from and write to text and excel files and debug errors.
  3. Write JAVA applet for windows based applications such as Word & Excel and JAVA scripts for CAD software such as CATIA & AutoCAD.
  4. Develop a small JRE based application or applet for a mechanical engineering subject.

Unit 1 - Overview of Java **No. of lectures - 01**

- **Prerequisites:** Concepts of programming, operate a computer
- **Objectives:**
  i. To introduce the student about the history and features of Java.
  ii. To make the student know about the process of installation of Java software.
  iii. To make the student to develop a simple Java program.
- **Outcomes:** After completing this unit, a student can;
  i. Install a JAVA SDK software or any JAVA compiler.
  ii. Develop a simple java program.
- **Unit Content:** Java history, Java features, Java vs. C and C++, Installing Java, Exploring the IDE, Simple Java program, JVM, command line arguments.
- **Content Delivery Methods:** Board, Chalk and talk

Unit 2 - General Programming **No. of lectures - 03**

- **Prerequisites:** Elementary Mathematics, basics of computer programming.
- **Objectives:**
  i. To introduce the student about the concept of variable, constants and data types.
  ii. To introduce the student about the branching and loop control structure.
- **Outcomes:** After completing this unit, a student can;
  i. Explain the concept of constants, variables and data types.
  ii. Develop programs using branching and loop control structure.
- **Unit Content:**
  Constants, Variable, data types, operators and expressions, branching, looping, calling object methods, creating a function. Program plan, assigning static properties & dynamic properties, adding runtimes, testing and deploying the program.
- **Content Delivery Methods:** Board, Chalk and talk

Unit 3 - Object Oriented Programming (OOP) **No. of lectures - 03**

- **Prerequisites:** Concept of variables, constants, operators and data types.
- **Objectives:**
  i. To introduce the student about the concept of branching control structure.
  ii. To introduce the student about the loop control structure.
- **Outcomes:** After completing this unit, a student can
  i. Concept of branching control structure.
  ii. Develop programs using branching and loop control structure.
- **Unit Content:**
  Define class, methods declaration, creating objects, constructors, methods overloading, static members, nesting of methods, overriding methods, final variables and methods, interfaces, packages.
- **Content Delivery Methods:** Board, Chalk and talk

Unit 4 - Interface and packages **No. of lectures - 01**

- Prerequisites: Constants, variables objects and classes, algorithm and flow charts
- **Objectives:**
  i. To introduce the student about the concept of variable, constants and data types.
  ii. To introduce the student about the branching and loop control structure.
- **Outcomes:** After completing this unit, a student can
  i. Explain the concept of constants, variables and data types.
  ii. Develop programs using branching and loop control structure.
- **Unit Content:** Using packages and interfaces, I/O classes creating files, reading/writing characters.
- **Content Delivery Methods:** Board, Chalk and talk

Unit 5 - Arrays, Strings and Vectors **No. of lectures - 01**

- **Prerequisites: Concept of matrices,** variables and constants
- **Objectives:**
  i. To introduce the student about the concept of array.
  ii. To introduce the student about the creation of 1-D array and multidimensional array.

- **Outcomes:** After completing this unit, a student can
  i. Explain the concept of array.
  ii. Develop matrices of different order.
- **Unit Content:** 1D and 2D arrays, strings, vectors
- **Content Delivery Methods:** Board, Chalk and talk

Unit 6 -Debugging **No. of lectures - 01**

- **Prerequisites:** Compilation and interpretation
- **Objectives:**
  i. To introduce the student about the concept of variable, constants and data types.
  ii. To introduce the student about the branching and loop control structure.
- **Outcomes:** After completing this unit, a student can
  i. Explain the concept of constants, variables and datatypes.
  ii. Develop programs using branching and loop control structure.
- **Unit Content:**
  Types of Errors exceptions, exception handling, using catch statements, using finally statement.
- **Content Delivery Methods:** Board, Chalk and talk

Unit 7 - Applets **No. of lectures - 02**

- **Prerequisites:** Principles of programming, objects and classes, Concept of HTML and SDK.
- **Objectives:**
  i. To introduce the student about the concept of variable, constants and data types.
  ii. To introduce the student about the branching and loop control structure.
- **Outcomes:** After completing this unit, a student can
  i. Explain the concept of constants, variables and data types.
  ii. Develop programs using branching and loop control structure.
- **Unit Content:**
  Applets, Applets vs. Applications, writing the applet code, creating executable applets, designing web page, running applets.
- **Content Delivery Methods:** Board, Chalk and talk

Unit 8 - Graphics **No. of lectures - 02**

- **Prerequisites:** Concepts of Computer graphics, objects and classes.
- **Objectives:**
  i. To introduce the student about the concept of variable, constants and data types.
  ii. To introduce the student about the branching and loop control structure.
- **Outcomes:** After completing this unit, a student can
  i. Explain the concept of constants, variables and data types.
  ii. Develop programs using branching and loop control structure.
- **Unit Content:**
  Graphics class, draw lines and rectangles, drawing circles and arcs, drawing polygons, drawing graphs and bar charts.
- **Content Delivery Methods:** Board, Chalk and talk

- **Term work:**

The term work is based on the following list of Computing Assignments.

1) Assignment on Fundamentals of Java programming.
2) Programming exercises on Variables and parameters.
3) Programming exercises on branching and looping
4) Programming exercises on Console I/O.
5) Assignment on object objects, classes and methods.
6) Programming exercises on Arrays, strings and vectors.
7) Programs on packages and interfaces.
8) Programs on Exception handling.
9) Assignment on Java Applet.
10) Assignment on graphics.

- **Text Books:**

1. Programming with JAVA: A Primer (4th Edition) - E. Balaguruswamy TMH
2. JAVA: The Complete Reference (5th Edition) - Herbert Scheldt (TMH)
3. Essential JAVA for Scientists and Engineers - Malan and Hahn (BH)

- **Reference Books:**

1. Object Oriented Programming through JAVA - P. Radhakrishna (University Press)
2. Java Programming for Beginners -Motwani (Shroff Publication)
3. Let us JAVA –Yeshwant Kanetkar (BPB)
4. JAVA in Easy Steps -Mike McGrath (TMH)

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-I
ME317Workshop Practice – IV (T.E. Part - I)

Teaching Scheme **Examination Scheme**
Practical: 2 hours a week **ICA: 50 Marks**

- **Course Objective:**

i. To make the students aware with various skills involved in manufacturing &Assembly.
ii. To develop skills to operate different machine tools.
iii. To make the students aware of limits, fits & tolerance while manufacturing assembly.
iv. To make students aware of operation sequence, speed feed selection for different materials & operations

- **Course Outcomes:**

i. To create confidence amongst the students in Production / manufacturing activities.
ii. Students should get experience about manual skills required to perform machining operations.
iii. To create confidence in students while designing limits, fits & tolerances during manufacturing.
iv. To create awareness in students regarding time management, work study, method study & tool engineering.

1. A composite job consisting of three components machined from Φ32 mm MS bar.

(Excluding commercial components) requiring minimum five operations listed below:

1. Turning
2. Drilling
3. Boring
4. Hand tapping
5. Milling
6. Internal & External V-threading
7. Grinding

2. The components of the composite job shall carry at least two specified close tolerance operations.In addition to the above, following operations are to be demonstrated during the term. (These are not to be included in the job operations for term work & exams.)

1. Shaping
2. Slotting
3. Grinding
4. Form Turning
5. Knurling
6. Grooving

4. Journal should contain detailed process sheet of above job.

5. Assessment of Workshop Practice-IV-Term work shall be done for 50 % Work or one major Component & Workshop Practice-V-Term work shall be done for remaining work at the end of T.E. (Mech.) Part II.

6. Practical examination of 6 Hrs. duration having component of 2 to 3 parts.

Note: Material specification for practical work & examination is raw material **Φ32mm MS bar.**

Books:

1. Workshop Technology (Volume II) by Raghuvanshi.

2. Workshop Technology (Volume II) by HajraChowdhary.

3. Workshop Technology (Volume II) by W.A.J.Chapman.

Reference Books:

1. Production Technology by P.C.Sharma.

2. Production Technology – HMT Handbook.

3. Production Technology (Volume II) by Gupte-Patel.

4. HGerling, All about Machine Tools, New Age International, 1995.

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-II
ME321 Heat and Mass Transfer

Teaching Scheme
Lectures– 3 Hours/week, 3 Credits
Tutorial – 2 Hour/week, 1 Credit

Examination Scheme
ESE– 70 Marks
ISE –30 Marks
ICA- 25 Marks
POE-25 Marks

Course Introduction:

This course deals with study of various modes of heat transfer such as conduction, convection and radiation. After completing the course, the students will be able to formulate and analyze a heat Transfer problem involving any of the three modes of heat transfer. The students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer.

The students will be able to analyze the performance of devices such as heat exchangers and also estimate the insulation needed to reduce heat losses wherever necessary.

Course Prerequisite

Student should have the knowledge of basic concepts of thermodynamics and laws of thermodynamics. Also students should have the knowledge of various thermal properties such as viscosity, thermal conductivity, temperature etc., to understand the subject.

Course Objectives:

1. To teach students the basic principles of conduction, radiation, and convection heat transfer.
2. To extend the basic principle of conservation of energy to systems which involve conduction, radiation, and heat transfer.
3. To train students to identify, formulate and solve engineering problems involving heat transfer.
4. To train students to identify, formulate and solve engineering problems involving forced convection heat transfer, natural convection heat transfer, and heat exchangers.

Course Outcomes:

1. Students will demonstrate an understanding of the basic concepts of conduction, radiation and convection heat transfer.
2. Students will demonstrate an understanding of the concept of conservation of energy and its application to problems involving conduction, radiation, and/or convection heat transfer. This principle will be used to formulate appropriate mathematical models and associated thermal boundary conditions.
3. Students will demonstrate the ability to formulate practical conduction heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique and evaluating the significance of results.
4. Students will demonstrate the ability to formulate practical forced and natural conduction heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique and evaluating the significance of results. Students will also demonstrate an ability to analyze the performance.

1. **Steady State Heat Conduction** **No. of lectures - 08**

- **Prerequisite:** Knowledge of basic laws of thermodynamics
- **Objectives:**

a. To study various modes of heat transfer
b. To study and analyze critical radius of insulation
c. To study and analyze the heat generation through the wall and cylinders

- **Outcomes:**

After completing this unit, student will be able to
a. Explain the various laws of heat transfer
b. Able to analyze critical radius of insulation for cylinder and sphere
c. Explain and analyze the heat generation phenomenon through plain wall and cylinder

•Unit Content

Modes of heat transfer. Basic laws of heat transfer, Introduction to modes of heat transfer, Thermal conductivity and its variation with temperature for various Engg. Materials (Description only). Derivation of Generalized Heat Conduction equation in Cartesian co-ordinate, its reduction to Fourier, Laplace and Poisson's equations. Generalized Heat conduction equation in cylindrical and spherical coordinates (no derivation) and its reduction to one dimension (1D), Heat conduction through plane wall, cylinder, sphere; composites, critical radius of insulation for cylinder and sphere. One dimensional steady state heat conduction with uniform heat generation (for wall & cylinder).Systems with negligible internal resistance, Biot and Fourier number and their significance, Lumped Heat capacity Analysis.

• **Content Delivery Methods**: Board, Chalk and talk, Use of Power point presentation

2. Extended Surfaces **No. of lectures - 03**

•Prerequisite: Knowledge of basic laws of heat transfer and thermodynamics

•Objectives:

a. To study and analyze heat transfer through the extended surfaces
b. To understand the applications of fins

•Outcomes:

After completing this unit, student will be able to
a. Explain the applications of fins
b. Analyze the various cases of the fins

•Unit Content

Types and applications of fins, Heat transfer through rectangular and circular fins. Fin effectiveness and efficiency.

•Content Delivery Methods: Board, Chalk and talk, PPT

3. Convection **No. of lectures - 09**

•Prerequisite: Knowledge of basic laws of heat transfer and dimensional analysis

•Objectives:

a. To study and analyze natural and forced convection heat transfer
b. To understand the practical applications of convection heat transfer

•Outcomes:

After completing this unit, student will be able to

a. Explain the practical applications of convection heat transfer.

b. Analyze Natural and forced convection heat transfer

•Unit Content

Concept of Hydrodynamic and thermal boundary layer, local and average convective coefficient for laminar and turbulent for flat plate and pipe. Dimensional analysis, Physical significance of dimensionless numbers, Reynolds analogy for laminar flow, Numerical correlations to solve various Problems. Dimensional analysis, Numerical correlations to solve natural convection problems

•Content Delivery Methods::Board, Chalk and talk, PPT

4. Boiling and condensation **No. of lectures - 02**

•Prerequisite: Knowledge of basic laws of heat transfer and basics of thermodynamics

•Objectives:

a. To study the pool boiling curve

b. To study various types of condensations

•Outcomes:

After completing this unit, student will be able to

a. Explain the pool boiling curve

B.Explain film wise and drop wise condensation

•Unit Content

Pool boiling curves, Forced boiling, Techniques for enhancement of boiling, Nusselt's theory of condensation, Film wise and drop wise condensation.(Only Descriptive)

•Content Delivery Methods: Board, Chalk and talk, PPT

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5. Radiation **No. of lectures - 08**

•Prerequisite: Knowledge of laws of heat transfer and thermodynamics

•Objectives:

a. To study and analyze various laws of radiation heat transfer

b. To study basic concepts of radiation heat transfer.

c. To study and analyze radiation heat exchange between two grey and black surfaces

•Outcomes:

After completing this unit, student will be able to

a. Explain the various laws of heat transfer

B.Analyze radiation heat exchange between two grey and black surfaces

c.Able to solve problems on Radiation shield and shape factor properties.

•Unit Content

Nature of thermal radiation, definitions of absorptivity, reflectivity, transmissivity, monochromatic emissive power. Total emissive power and emissivity, Concept of black body &gray body,Kirchhoff's law, Wein's law and Planck's law.Deduction of Stefan Boltzmann equation.Lambert cosine rule, Intensity of radiation. Energy exchange by radiation between two blacksurfaces with non-absorbing medium in between and in absence of reradiating surfaces. Geometric shape factor. Energy exchange by radiation between two gray surfaces

without absorbing medium and absence of irradiation and Radiosity. Radiation network method, network or two surfaces which see each other and nothing else.

•**Content Delivery Methods:** Board, Chalk and talk

6. Heat Exchangers **No. of lectures - 06**

•**Prerequisite:** Knowledge of laws of heat transfer and thermodynamics

•**Objectives:**

a. To study classification of heat exchanger

b. To study and analyze heat transfer through parallel and counter flow heat exchanger by LMTD method

c. To study and analyze heat transfer through parallel and counter flow heat exchanger by NTU method

•**Outcomes:**

After completing this unit, student will be able to

a. Explain the types of heat exchanger

b. Able to understand and analyze heat transfer of parallel and counter flow heat exchanger By LMTD method

c. Able to understand and analyze heat transfer of parallel and counter flow heat exchanger by NTU method

D.Understand the concept like fouling of heat exchangers and design considerations in heat Exchangers

•**Unit Content**

Classification & Types of Heat exchangers, Fouling factor, and Overall heat transfer coefficient, Analysis by LMTD and NTU method for parallel and counter flow, Design consideration for Heat exchangers. Heat pipe.

•**Content Delivery Methods**: Board, Chalk and talk, PPT

7. **Mass Transfer** **No. of lectures - 02**

•**Prerequisite:** Knowledge of laws of heat transfer

•**Objectives:**

a. To study various modes of mass transfer

b. To study the various laws of mass transfer.

•**Outcomes:**

After completing this unit, student will be able to

a. Explain the modes of mass transfer

b.State the laws of mass transfer

C.Explain the analogy between heat transfer and mass transfer

•**Unit Content**

Introduction, Modes of mass transfer, Analogy between heat and mass transfer, Mass diffusion (Mass basis, Mole basis), Fick's law of diffusion.

•**Content Delivery Methods:** Board, Chalk and talk

8. **Finite Difference applications in heat conduction and convection No. of lectures - 02**

•Prerequisite: Knowledge of laws of heat transfer and Numerical methods

•Objectives:

a. To study finite difference methods for solving heat transfer problems

b. To understand concepts of steady state boundary conditions

•Outcomes:

After completing this unit, student will be able to

a. Explain the concept of finite difference methods

b.Understand the concepts of boundary conditions in conduction and convection.

•Unit Content

Introduction to finite difference, Finite difference methods for solving conduction and convection problems. One dimensional steady state heat conduction-boundary conditions, Finite difference applications in convective heat transfer (Introduction only)

•Content Delivery Methods: Board, Chalk and talk

List of Experiments

Experiment must be set simultaneously and the no. of students in each group working on a setup shall not exceed 04students. Any08Experiments based on following list plus two computers application assignments.

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of Composite wall or lagged pipe.
3. Determination of thermal conductivity ofMetals at different temperatures
4. Determination of Heat Transfer Coefficient for natural convection.
5. Determination of Heat Transfer Coefficient for forced convection.
6. Determination of Emissivity.
7. Determination of Stefan Boltzmann Constant.
8. Boiling Heat Transfer.
9. Determination of heat transfer coefficient in drop wise and film wise condensation.
10. Trail on Heat Exchangers.
11. Heat Pipe Demonstration/Trial.
12. Determination of diffusivity of volatile liquid..

Note- The parameters such as Temperature, flow rate, pressure shall be acquired by Data acquisition system or data logger to ensure precise steady state condition while performing above experiments.

Instructions for Practical Exam:

1. Four to Five experiments shall be selected for Practical Examination.
2. The Number of Students for each practical set up would not be more than 04 Students.
3. Oral will be based on the Practical performed in the examination and the experiments Included in the Journal.

Text Books:

1. A Text Book on Heat Transfer by Dr. S. P.Sukhatme, Orient Longman Publication, Hyderabad
2. Heat Transfer by P.K. Nag, Tata McGraw hill Publishing Company Ltd., New Delhi.
3. Heat and Mass Transfer by R.K. Rajput, S. Chand & Company Ltd., New Delhi. 110055

4. Engineering Heat and Mass Transfer, Mahesh M.Rathore,University Science Press, New Delhi-110002

Reference Books:

1. Heat Transfer by J.P. Holman , McGraw Hill Book Company, New York.
2. Fundamentals of Heat and Mass Transferby R.C. Sachdev, Willey Eastern Ltd.,
3. Heat Transfer – A Practical approach by – Ynus -A – Cengel(Tata cGraw Hill)
4. Heat Transfer by Chapman A.J. McGraw Hill Book Company, New York.
5. Heat and Mass Transfer, S.C. Arrora and S. Dokoundwar, DhanpatRai and Sons, Delhi.
6. Fundamentals of Heat and Mass Transfer by C.P. Kothandaraman
7. Heat and Mass Transfer by Dr. D. S.Kumar S.K. Kataria& Sons, Delhi.
8. Fundamentals of Heat & Mass Transfer (Fifth Edi.), Frank P.Incropera, David P. Dewitt, Wisley India.
9. Heat & Mass Transfer, G. Kamraj, P.Raveendran SciTech Publi.
10. Heat Transfer V C RAO University press
11. Heat Transfer Dr. S. N. SaphaliTechmachpublication Pune

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-II
ME322 Internal Combustion Engine

Teaching Scheme
Lectures– 3 Hours/week, 3 Credits
Practical – 2 Hour/week, 1 Credit

Examination Scheme
ESE– 70 Marks
ISE –30 Marks
ICA- 25 Marks

Course Introduction:

This course provides an introduction to Internal Combustion Engine. It introduces four stroke and two stroke engine working, also highlights the difference between these two. It briefs introduction about fuel system for SI and CI engine. It focuses on normal and abnormal combustion in SI and CI engine. This course also includes performance parameter and its testing. In this subject student will learn the various engine systems like cooling, lubrication, starting systems etc. It touches to some of the recent advance in the Engine field like Electronic Engine management system, Carbon Credit system, Hybrid vehicles, Alternative fuels etc.

Course Prerequisite:

Student should have knowledge of Basic thermal Principal, Thermodynamics, and Heat Transfer. They should know basic processes and cycles. A sound background of analysis of thermal systems is essential for successful completion of this course.

Course Objectives: During this course, student is expected

1. Distinguish the different types of engine constructions and their thermodynamic principles.
2. Differentiate the constructional details of various fuel systems used in different types of I. C. Engines and calculate major dimensions of carburetor and fuel injection system.
3. Apply the basic knowledge to infer the different methods for enhancing the performance of I. C. engines
4. Correlate the difference in SI and CI engine combustion processes with the design of combustion chambers used in these engines
5. Evaluate the performance parameters of I. C. engines to justify their use in different applications.
6. Categorize different alternative fuels suitable for different engine applications and compare the pollutants formed in these engines and their control methods

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

1. Recognize and understand the reasons for differences in the construction of different types of internal combustion engines.
2. Understand the reasons for differences among operating characteristics of different engine types and designs
3. Select the appropriate engine for a given application.

4. Conduct performance tests on engines and Compare experimental results with Theoretical predictions.
7. Compare experimental results with theoretical predictions and make proper justifications.

Section I

Unit 1 - Introduction to I. C. Engine **No of lectures – 05**

- **Prerequisite:** Knowledge of Basic Thermal concepts like Temperature, Pressure, Process, Cycle etc.
- **Objectives:**
  1. To Introduce I. C Engine, its cycle.
  2. To study theoretical and actual cycle of Engine.
  3. To know valve timing and port timing diagram
- **Outcomes:** After completing this unit, student will be able to
  1. Explain working of I C Engine.
  2. Differentiate between 4 stroke and 2 stroke Engine.
  3. Differentiate between Actual and theoretical cycle
- **Unit Content:**
  Introduction, Classification of I.C. Engines, Engine Cycles-Otto and Diesel Cycle, Deviation of actual cycles from air standard cycles, Valve timing diagram for high and low speed engines, Port timing diagram for two strokes S.I. Engines.
- **Content Delivery Methods:** Board, Chalk and talk, PPT.

Unit 2–Fuel System for S. I. Engines **No of lectures – 06**

- **Prerequisite:** Basic Knowledge of engine fuels, its properties like Ignition Point, Boiling Point, Volatility, etc.
- **Objectives:**
  1. To introduce procedure of mixing air and Fuel.
  2. To know mixture requirement at different load condition
  3. To impart knowledge of design of Carburetor.
- **Outcomes:** After completing this unit, student will be able to
  1. Understand need of mixture preparation.
  2. Explain working of Carburetor.
  3. Determine dimensions of Carburetor.
- **Unit Content:**
  Engine fuel requirements, Mixture requirements, Simple carburetor, and Additional systems in modern carburetor, compensating devices, Calculation of air fuel ratio (exact and approximate methods), Calculation of main dimensions of air and fuel supply (Numerical calculations of main dimensions of carburetor), Electronic Petrol injection system (MPFI).
- **Content Delivery Methods:** Board, Chalk and talk**,** PPT.

Unit 3–Fuel System for C. I. Engines **No of lectures – 05**

- **Prerequisite:** Diesel fuel properties, working of some basic components like pump, strainer, hoses, nozzles etc.

- **Objectives:**
  1. To understand working of Fuel System for C. I. Engines.
  2. To know process of spray formation, injection.
- **Outcomes:** After completing of this unit, student will be able to-
  1. Explain the fuel injection system.
  2. Calculate the dimensions of fuel injector nozzle.
- **Unit Content:**

Requirements of fuel injection system for C.I. Engines, Types of injection systems- Individual pump, Common rail and Distributor systems, Unit injector, Types of fuel nozzles- single hole, multi hole, pintle and pintaux, Governing of C.I. Engines, (Numerical on calculations of main dimensions of fuel injection system).

- **Content Delivery Methods:** Board, Chalk and talk, PPT.

Unit 4–Supercharging **No of lectures – 04**

- **Prerequisite:** Working of some basic compressor and its types, basic engine cycle.
- **Objectives:**
  1. To understand working of supercharger and turbocharger.
  2. To understand effect of supercharging on thermodynamic cycle.
- **Outcomes:** After completing this unit, student will be able to-
  1. Explain the type and working of supercharger and turbocharger.
  2. Explain limitation of supercharger and turbocharger for SI and CI engine.
- **Unit Content:**

  Purpose of supercharging, Turbo charging, Thermodynamic cycle of supercharged and turbocharged Engines, Advantages and disadvantages, Limits of supercharging for S.I. and C.I. Engines.
- **Content Delivery Methods:**

  Board, Chalk and talk**,** PPT, Video

Section II

Unit 5–Combustion in SI Engine **No of lectures – 05**

- **Prerequisite:** Combustion phenomenon, Heat release process.
- **Objectives:**
  1. To learn stages of combustion in SI engine.
  2. To understand the normal and abnormal combustion in SI Engine.
  3. To learn knocking in SI engine.
- **Outcomes:** After completing this unit, student will be able to-
  1. Explain the combustion in SI engine.
  2. Parameter affecting on normal and abnormal combustion.
- **Unit Content:**

  Stages of combustion in S.I. Engines, Ignition lag, Flame propagation, Factors affecting flame speed, Abnormal combustion, Influence of operating variables on knocking, Octane number, HUCR, Requirements of combustion chambers of S.I. Engines and its types.

- **Content Delivery Methods:**
  Board, Chalk and talk, PPT, Video

Unit 6–Stages of combustion in C.I. Engines **No of lectures – 05**

- **Prerequisite:** Combustion in phenomenon, Heat release process, Properties of diesel fuel.
- **Objectives:**
  1. To learn Stages of combustion CI engine.
  2. To know abnormal combustion in CI engine.
  3. To understand difference between SI engines knocking and CI engine knocking.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain Stages of combustion CI engine.
  2. Explain the knocking in CI engine.
- **Unit Content:**

Stages of combustion in C.I. Engines, Delay period, Factors affecting delay period, Abnormal Combustion-Diesel knock, Influence of engine design and operating variables on diesel knock, Requirements of combustion chambers for C.I. Engines and its types. Comparison of abnormal combustion in S I and C I Engines. Cetane number, Antiknock Agent.

- **Content Delivery Methods:** Board, Chalk and talk**,** PPT.

Unit 7 –Engine performance **No of lectures – 05**

- **Prerequisite:** Basic concepts like Energy, Power, Engine working, Principle of orifice etc.
- **Objectives:**
  1. To understand performance parameter of Engine
  2. To learn heat balance sheet of Engine.
  3. To know Morse test of Multi cylinder engine
- **Outcomes:** After completing this unit, student will be able to-
  1. Calculate the performance parameters of the engine.
  2. Draw heat balance sheet.
- **Unit Content:**

Performance parameters, Measurement of performance parameters like torque, power, and Volumetric Efficiency, Mechanical Efficiency, bsfc, Brake and Indicated Thermal efficiencies. Heat Balance Sheet. (Numerical on engine Performance and Heat Balance Sheet)

- **Content Delivery Methods:**
  Board, Chalk and talk

Unit 8–Alternative Fuels and Engine Emission **No of lectures – 05**

- **Prerequisite:** Regular fuels of Engine, Basic reactions of fuel.
- **Objectives:**
  1. To find alternative fuel for I C Engine.
  2. To understand pollution control devices.
  3. To know Pollution norms.

- **Outcomes:** After completing this unit, student will be able to
  1. Explain alternative fuels for I C Engine.
  2. Explain the basic pollutants from the engine.
  3. Explain the pollution control devices.
- **Unit Content:**

Various alternative fuels and their suitability for I. C. Engines.S.I. Engine emissions (HC, CO, NOx) Control methods, Catalytic converters.C.I. Engines Emissions (CO, NOx, Smog, Particulate), Control methods, EGR, Bharat Norms III and IV

- **Content Delivery Methods:** Board, Chalk and talk
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TERM WORK

Term work (minimum 3 from group A and B, and all from Group C)

Group A (Study Group)

i. Constructional details of I.C. engines
ii. Study of Engine Cooling and Lubrication system
iii. Study of Ignition systems and Starting systems
iv. Study of fuel system for S.I. and C. I. engines

Group B (Trial Group)

i. Constant Speed Test (Influence of load on performance)
ii. Morse Test
iii. Heat balance sheet
iv. Test on computer controlled I.C. Engine/ Variable Compression Ratio Engine
v. Measurement of exhaust emissions of SI / CI engines

Group C

i. Assignment on recent trends in IC Engine.
ii. Visit to an engine manufacturing company / repairing unit.

Text books:

1 Internal Combustion Engines, Mathur and Sharma, DhanpatRai.
2 Engineering Fundamentals of the Internal Combustion Engine, Willard Pulkrabeck, Prentice Hall
3 Internal Combustion Engines, R. K. Rajput, Dhanpat Rai Publications.
4 Internal Combustion Engines, V.Ganesan, McGraw Hill.

Reference books:

1 Internal Combustion Engines Fundamentals, John Heywood, McGraw Hill
2 Internal Combustion Engines Emission and Control, EranSher, SAE
3 Engine Emissions Purandir, Narosa
4 Alternative Fuels, S.S Thipse, Jaico
5 Internal Combustion Engines Fundamentals, Maleev, McGraw Hill
6 Internal Combustion Engines Vol. 1 and Vol. 2, C.F Taylor, MIT Press
7 Internal Combustion Engines, *Obert*, McGraw Hill
8 Internal Combustion Engines: AppliedThermo sciences, Fergusson & Kirkpatrick, Wiley.
9 SAE Handbook, SAE, SAE.

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-II
ME323 (CAD, CAM & CAE)

Teaching Scheme
Lectures– 3 Hours/week,
Practical – 2 Hour/week,

Examination Scheme
ESE– 70 Marks
ISE –30 Marks
ICA- 25 Marks

Course Introduction:

Now a day's industries cannot survive worldwide competition unless they introduce new products with better quality, at lower cost, and with shorter lead time. Accordingly, they have tried to use the computer's huge memory capacity, fast processing speed, and user-friendly interactive graphics capabilities to automate and bind together thus reducing the time and cost of product development and production. Computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE) are the technologies used for this purpose during the development of mechanical product with best quality and lowest cost. Students must have knowledge of CAD, CAM, and CAE. Therefore, this course contains syllabus related to CAD, CAM and CAE activities. The syllabus is divided into two sections, each section contains four chapters.

Course objectives:

i. To create an awareness regarding Geometric Modeling activities in Industries.
ii. To create an awareness regarding CAM activities in Manufacturing Industries.
iii. To develop part programming capabilities for CNC machines.
iv. To empower students to learn advanced tools in Automation.
v. To utilize modern tools for design, analysis and manufacturing activities.

Course Outcomes: After completion of the course the students will be able to:-

1. Implement concept of modern product cycle.
2. Apply knowledge of the fundamental mathematical theories for geometric Transformation.
3. Create the geometric model using CAD modeling software.
4. Apply CAE analysis tool for simulation of 1-D component.
5. Implement the concept of GT and CAPP.
6. Apply the concept of FMS.
7. Select appropriate tooling for CNC machine.
8. Develop part programming to operate CNC milling & turning machine to manufacture a Mechanical part.

Section-I

Unit 1: Introduction to CAD / CAM/CAE **No. of Lectures: 03**

• **Prerequisite:** Traditional design and manufacturing phages, Knowledge of manufacturing and machining processes, etc.

• **Objectives:**

1. To understand the modern product cycle and CAD/CAM/CAE.
2. To identify input/output devices.
3. To understand the functions of graphics software.

• **Outcomes:** After completing this unit, students will be able to-

1. Implement concept of modern product cycle.
2. To select appropriate CAD / CAM/CAE software for design, analysis and manufacturing Activities.

• **Unit content:**

Product Cycle and CAD / CAM/CAE, Advantages of CAD / CAM/CAE, Hardware used for CAD/CAM/CAE system, List of input/output devices, Functions of Graphics Software, `Selection of CAD / CAM/ CAE Software.

• **Content Delivering Methods:** Board, Chalk & talk and Power Point Presentation.

Unit 2: Computer Graphics and Geometric Modeling **No. of Lectures: 08**

• **Prerequisite:** Knowledge of basic transformation command from AutoCAD software, Knowledge of engineering graphics and basic curves etc.

• **Objectives:**

1. To understand mathematical method of geometric transformation.
2. To understand the use of homogeneous transformation.
3. To study and implement concept of CAD/CAM data exchange
4. To understand different types of geometric modeling and their use in industry

• **Outcomes:** After completing this unit, students will be able to-

1. Apply knowledge of the fundamental mathematical theories for geometric Transformation.
2. Create the geometric model using CAD modeling software.

• **Unit content:**

Geometric Transformations, Homogeneous Coordinates, Windowing and Viewing Transformations, Coordinate Transformations, Standardization in Graphics Software, CAD / CAM Data Exchange. Introduction to Geometric Modeling and its types, Parametric representation of basic entities like line and circle, Introduction to basic curves - Bezier, B-Spline, NURBS, concept of CSG and Boolean operations, Feature based modeling.

• **Content Delivering Methods:** Board, Chalk & talk, Power Point Presentation, Animations.

Unit 3: Finite element method **No. of Lectures: 04**

• **Prerequisite:** Basic knowledge of strength of material, Machine Design, Applied Mechanics

• **Objectives:**

1. To understand General steps of the Finite Element Method.
2. To derive the stiffness matrix for the 1-D bar element.
3. To select appropriate simulation or analysis software

- **Outcomes:** After completing this unit, students will be able to-
  1. Implement General steps of the FEM
  2. Carry out Structural and thermal analysis of 1-D bar elements

• Unit content:

Definition, Types of analysis, terms used in FEM, types of nodes and elements, General Steps of the FEM, Structural and thermal analysis of 1-D bar elements, Introduction to latest FEA software

• Content Delivering Methods: Board, Chalk & talk, Power Point Presentation, Animations.

Unit 4: Automation **No. of Lectures: 05**

• Prerequisite: Traditional manufacturing phages, Knowledge of manufacturing and machining centers and processes, etc.

• Objectives:

1. To understand the management approach of Group Technology and part classification based on various methods.
2. To study and understand the concept of computer aided process planning and its types.
3. To understand computer integrated manufacturing and its advantages.

- **Outcomes:** After completing this unit, students will be able to-
  1. Implement concept of group technology for making part family.
  2. Develop computer aided process plan for simple mechanical component.

• Unit content:

Concept & Definition of Automation, Types, Advantages and Limitations of Automation, Automation and CAD/CAM, CIM and CAD / CAM, Group Technology, part family, Classification and Codification System, Merits and Demerits of Group Technology, CAPP, Retrieval and Generative type of CAPP, MRP, concept of ERP, concept of Rapid Prototyping,

• Content Delivering Methods: Board, Chalk & talk, Power Point Presentation, Animations.

Unit 5: Fundamentals of NC system **No. of Lectures: 06**

• Prerequisite: Traditional machining processes, Knowledge of manufacturing and machining centers and processes, etc.

• Objectives:

1. To apply steps of NC system.
2. To demonstrate concept of flexible manufacturing system.
3. To explain types of NC system.

• Outcomes: After completing this unit, students will be able to-

1. Implement steps of NC system.
2. Demonstrate concept of flexible manufacturing system.

- **Unit content:**

Evolution of NC and Retrofitting, Elements of NC Manufacturing System, concept of work zero and machine zero, Types of NC systems, Structure, Drives and other devices, Steps in NC Manufacturing, Advantages and Disadvantages of NC Technology, Flexible Manufacturing System (FMS), Elements of FMS, Applications of FMS, Merits and Demerits in FMS.

• **Content Delivering Methods:** Board, Chalk & talk, Power Point Presentation, Animations.

Unit 6: CNC- DNC Technology **No. of Lectures: 03**

• **Prerequisite:** Knowledge of machining processes, Knowledge of manufacturing and Machining centers etc.

• **Objectives:**

1. To classify computerized numerical control system.
2. To describe Direct Numerical Control System.
3. To understand the concept of Adaptive control system.

• **Outcomes:** After completing this unit, students will be able to-

1.Apply concept of adaptive control system.

• **Unit content:**

Classification of CNC machine tools, CNC controllers, Features and Advantages of CNC, Adaptive Control, Advantages of Adaptive Control, Direct Numerical Control, Types of Direct Numerical Control, Advantages and Disadvantages of Direct Numerical Control.

• **Content Delivering Methods:** Board, Chalk & talk, Power Point Presentation, Animations.

Unit 7: Tooling for CNC Machines **No. of Lectures: 03**

• **Prerequisite:** Knowledge of traditional machine tools, Knowledge of selection of correct tools, Knowledge of machine tools and processes etc.

• **Objectives:**

1. To design automatic tool changer and tool holding system.
2. To design modular tooling system and tool magazine.
3. To demonstrate tool setting in CNC

• **Outcomes:** After completing this unit, students will be able to-

1. Design the tooling required for .CNC and VMC machines.

• **Unit content:**

Tool holders, Adapters, Tool magazines, Automatic tool changers, Pallets, Tool setting, Modular tooling.

• **Content Delivering Methods:** Board, Chalk & talk, Power Point Presentation, Animations.

Unit 8: Manual Part Programming **No. of Lectures: 08**

• **Prerequisite:** Knowledge of traditional machine tool, Knowledge machine tools and processes etc

• **Objectives:**

1. To implement G-code and M-code for development of part program for CNC Lathe and Milling machines.
2. To apply concept of machine zero and work zero.
3. To apply concept of subprogram, Do-loop and canned cycle.

• **Outcomes:** After completing this unit, students will be able to-

1. Develop part program for any part drawing.

• **Unit content:**

Principles of an NC Program, Word Address Format (WAF), Machining Formulas, Tool Length and Cutter Diameter Compensation, Canned Cycles for Lathe, Milling and Drilling, Introductory treatment of Subprogram, Subroutines, DO Loop, Macros.

- **Content Delivering Methods:** Board, Chalk & talk, Power Point Presentation, Animations.

- **List of Experiments**

1. Assignment on Modeling & Drafting of any two mechanical components.
2. Assignment on Modeling of simple Assembly of around 3-5 machine components.
3. Assignment on FEA based structural analysis of simple mechanical component.
4. Assignment on FEA based thermal analysis of simple mechanical component.
5. Part programming of one job using CAM software or Programming and manufacturing of one job on CNC lathe or CNC Milling machine.
6. Assignment based on Industrial visit and its report based on CNC/FMS/Automation.

Text books:

1. Introduction to CAD/CAM, Rao P.N., -Tata McGraw Hill Publishing Co.
2. Automation, Production Systems and Computer Integrated Manufacturing, Grover M.P.- Prentice Hall of India
3. Numerical Control -Computer Aided Manufacturing, Kundra, Rao, Tiwari- TM Hill Pub.Co.
4. CAD/CAM/CAE, Chougule N.K.- SCITECH Publications (I) Pvt. Ltd.
5. CAD/CAM/CIM, P. Radhakrishanan.

Reference Books:

1. Theory and Practice, Ibrahim Zeid – CAD/CAM - Tata McGraw Hill Publishing Co.
2. CAD/CAM - Mastering, Ibrahim Zeid –-Tata McGraw Hill Publishing Co.
3. Computer Integrated Design and Manufacturing, D.D. Bedworth, M.R Henderson & P.M. Wolfe- -Tata McGraw Hill Pub. Co.
4. CAD/CAM Theory and Concepts, Kuldeep Sareen, C. Grewal, -S.Chand & Co.Ltd.
5. Computer Graphics by Hearn and Baker.

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-II
ME324 Machine Design-II

Teaching Scheme
Lectures – 3 Hours/week, 3 Credits
Practical – 2 Hour/week, 1 Credit

Examination Scheme
ESE– 70 Marks
ISE –30 Marks
ICA- 25 Marks
OE- 25 Marks

- **Course Introduction:**
  This course seeks to provide an introduction to design of various machine elements and discusses various design procedures, requirements, and design methods. It introduces the design procedure for various types of gears like spur gears, helical gears, bevel gears and worm gears along with the introduction to AGMA standard. A further content explains in detail the significance of pressure vessels, design procedure, and introduction to various standards used for pressure vessels. The concept of optimum design and application of it for design of simple machine element like shaft is discussed. The different types of bearings, their significance and the selection of the rolling contact bearings from Manufacturer's Catalogue and the design considerations for sliding contact bearing are also explained in the content of the course.

- **Course Prerequisite:** Student shall have knowledge of function of different machine elements such as different types of gears, bearings, shafts, keys, etc. A sound background of Applied Mechanics, Analysis of Mechanical Element, and Machine Design I is essential for successful completion of this course.
- **Course Objectives: During this course, student is expected**
  1 Design of Spur gear and identify the failure modes of Gear
  2 Design of helical gear under different loading condition
  3 Design pressure vessel and study of different codes for pressure vessel design
  4 Apply the concept of optimum design for design of simple Machine element
  5 Design of bevel gear under different loading condition
  6 Design of Worm and Worm Wheel under different theories of failure.
  7 Select the Bearing from Bearing Manufacturing Catalogue
  8 Analyze the performance of a hydrodynamic Journal Bearing
- **Course Outcomes: At the end of this course, student will be able to**
  1 To identify various modes of gear failure
  2 To design various transmission system elements like spur, helical, bevel and worm gears, etc.
  3 To explain different codes for design of gears and pressure vessels.
  4 To provide optimum design of simple machine elements such as shaft
  5 To select bearing from Manufacturer's catalogue
  6 To implement the knowledge for design of a gear box and pressure vessel.

Section I

Unit 1– Spur Gears **No of lectures – 06**

- **Prerequisite:** Knowledge of Applied Mechanics, Analysis of mechanical elements, and Theory of Machines II.
- **Objectives:**
  1. To study basics related to spur gear design.
  2. To understand the different modes of failure.
  3. To design the spur gear
- **Outcomes:** After completing this unit, student will be able to
  1. Explain the basics concepts and equations related to gear design
  2. Apply the design considerations for design of a spur gear
  3. Analyze the failure modes of gears
- **Unit Content:**
  Design considerations of gears, gear materials, types of gear tooth failures, hunting tooth, gear tooth loads, minimum number of teeth, face width, Lewis equation, Spott's equation, Buckingham's' Equation (Introductory treatment), gear design for maximum power transmission, Introduction to AGMA code.
- **Content Delivery Methods:** Board, Chalk and talk, and Power Point Presentation.

Unit 2– Helical Gears **No of lectures – 04**

- **Prerequisite:** Knowledge of Applied Mechanics, Analysis of mechanical elements, Theory of Machines II, and concept of spur gear design.
- **Objectives:**
  1. To study the terminology, virtual number of teeth and force analysis of helical gear.
  2. To understand the concept of, herringbone and double helical gears
  3. To design the helical gear
- **Outcomes:** After completing this unit, student will be able to
  1. Explain the virtual number of teeth and difference between herringbone and double helical gears
  2. Analyze the forces acting on helical gears.
  3. Design the helical gear under different loading conditions
- **Unit Content:**
  Virtual number of teeth, force analysis, beam and wear strength, effective load on gear tooth, introduction to herring bone gears.
- **Content Delivery Methods:** Board, Chalk and talk.

Unit 3– Pressure vessel **No of lectures – 07**

- **Prerequisite:** Knowledge of Analysis of mechanical elements and Theories of failure criteria
- **Objectives:**
  1. To study various failure criteria for pressure vessels
  2. To design pressure vessel
  3. To study different codes used for pressure vessels
- **Outcomes:** After completing this unit, student will be able to
  1. Explain the different codes used for pressure vessels
  2. Apply different equation s for design of pressure vessels
  3. Analyze the reinforcing pad requirement for opening in pressure vessel and calculate its dimensions

- **Unit Content:**
  Types of pressure vessels- horizontal and vertical, thick and thin cylinders, failure criteria of vessels – Lame's equation, Clavarino's equation, Birnies equation, compound cylinders, Introduction to design of pressure vessels, shell and end closures. Effect of opening and nozzle in shell and covers, Introduction to Codes like IS, IBR, different sections of ASME used for design of pressure vessels (Introductory treatment).
- **Content Delivery Methods:** Board, Chalk and talk, and Power Point Presentation

Unit 4– Optimum Design **No of lectures – 03**

- **Prerequisite:** Concepts Analysis of Mechanical elements and Machine Design I.
- **Objectives:**
  1. To study the Johnsons method for optimum design.
  2. To design simple mechanical element like shaft using the principles of optimum design.
- **Outcomes:** After completing this unit, student will be able to-
  1. Explain the concept of adequate design and optimum design.
  2. Design simple mechanical element using Johnson's method of optimum design.
- **Unit Content:**
  Introduction to optimum design for mechanical elements, adequate and optimum design, and Johnson's method of optimum design- simple problems on shafts subjected to torsional and bending moments
- **Content Delivery Methods: Board, Chalk and talk.**

Section II

Unit 5– Bevel Gear **No of lectures – 05**

- **Prerequisite:** Knowledge of spur and helical gear design
- **Objectives:**
  1. To study the bevel gear terminology and force analysis
  2. To understand the requirements for bevel gear mountings
  3. To design the bevel gears
- **Outcomes:** After completing this unit, student will be able to
  1. Analyze the different forces acting on bevel gears
  2. Design the bevel gear under different loading conditions
- **Unit Content:**
  Terminology and geometrical relation, force analysis, mounting of bevel gears, beam strength and wear strength, dynamic tooth load.
- **Content Delivery Methods:** Board, Chalk and talk and Power Point Presentation

Unit 6– Worm Gear **No of lectures – 05**

- **Prerequisite:** Knowledge of analysis of spur, helical and bevel gears.
- **Objectives:**
  1. To study the terminology and standard dimensions for worm gears
  2. To design the worm gears
  3. To study the thermal considerations for worm gears.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain the force analysis and friction in worm gears

2. Design the worm gear
3. Apply thermal consideration s for worm gear design

- **Unit Content:**
  Terminology and geometrical relations, materials, standard dimensions and recommendations of worm gearing, force analysis of worm drive, friction in worm gear, efficiency and design criteria of worm drive as per IS7443-1974, load rating of worm drive, strength and wear rating of worm gear, thermal considerations in worm drive.
- **Content Delivery Methods:** Board, Chalk and talk and Power Point Presentation

Unit 7 -Rolling Contact Bearing **No of lectures – 05**

- **Prerequisite:** Knowledge of Machine Design I
- **Objectives:**
  1. To study the load capacities of the bearings.
  2. To select the bearing from Manufacturer's catalogue.
  3. To design bearings considering variable load and speed conditions.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain the different types of bearing, load capacities and load life relationship.
  2. Select a bearing from Manufacturer's catalogue
  3. Calculate equivalent load considering variable load and speed conditions
- **Unit Content:**
  Types, static and dynamic load capacities, Stribeck's equation. Equivalent bearing load, load-life relationship, bearing life, load factor, selection of bearing from manufactures catalogue. Ball and Roller bearing, Design for variable load and speed, Bearings with probability of survival other than 90 %. Lubrication and mountings, dismounting and preloading of bearings.
- **Content Delivery Methods:** Board, Chalk and talk and Power Point Presentation

Unit 8– Sliding contact bearing **No of lectures – 05**

- **Prerequisite:** Knowledge of analysis of mechanical elements, Machine Design I and rolling contact bearings.
- **Objectives:**
  1. To understand the concept of hydrodynamic and hydrostatic lubrication
  2. To analyze the performance of hydrodynamic bearing
- **Outcomes:** After completing this unit, student will be able to
  1. To explain about hydrodynamic and hydrostatic lubrication
  2. To analyze the hydrodynamic bearing performance
- **Unit Content:** Bearing material and their properties, bearing types and their construction details. Hydro-dynamic lubrication: Performance analysis of Hydrodynamic bearing by Raimondi and Boyd method. Introduction to hydro static bearings (Introductory Treatment).
- **Content Delivery Methods:** Board, Chalk and talk and Power Point Presentation

- **Term Work**

a) Design and drawing of (**any one**) using design data book
1) Gear box
2) Pressure vessel

b) Assignments on (minimum four)

1. Spur and Helical gears
2. Bevel and worm gears
3. Pressure vessels
4. Rolling and sliding contact bearings
5. Optimum Design

(Note: Assignments should based on the topics which are not covered in **Mini Project**)

- **Text book:**

1) Design of Machine Elements by V.B.Bhandari.
2) Machine Design by Robert L. Norton.
3) PSG Design data Book.

Reference Books:

1) Design of Machine Elements by J.E. Shigely
2) Engg. Design Material and processing approach by George Dieter.
3) Design of Pressure Vessel by Harvey.
4) Machine Design by Hall, Holowenko, Schaum's outline series.
5) Introduction to Tribology by Mujumdar.
6) Machine Tool Design by N.K.Mehta.
7) Tribology by R.B.Patil

Solapur University, Solapur

T.E. (Mechanical Engineering) Semester-II
Professional Elective-IV Course-I
ME325 Experimental Stress Analysis

Teaching Scheme	Examination Scheme
Lectures– 3 Hours/week, 3 Credits	ESE– 70 Marks
Practical – 2 Hour/week, 1 Credit	ISE –30 Marks
	ICA- 25 Marks

- **Course Introduction:**
  This course seeks to provide introduction of basic of photo elasticity, Strain gauges and coating methods. It introduces poloriscope and its application for two dimensional Photo elastics model. A further content explains in detail selection of suitable Photo elastics materials and different analysis techniques. This course also provides information of proper selection of strain gauges, its applications for different mechanical elements. Components analysis procedures with help of strain gauge rosette are also covered in content of the course.

- **Course Prerequisite:** Student shall have knowledge of Applied Physics, electrical Circuit and coating methods for machine elements, also sound background analysis of mechanical element is essential for successful completion of this course**.**

- **Course Objectives:** During this course, student is expected
  1. To study optics law for two dimensional photos elasticity and different photo elastic technique.
  2. To study different types of polar scope and its different arrangement.
  3. To Study the different photo elastic materials and its property.
  4. To conduct analysis of Principal stress difference (σ_1- σ_2) at the given point
  5. To Study different strain gauges and its materials.
  6. To Study selection of strain gauges and its bonding procedure on Mechanical element.
  7. To Study different Strain Gauge Rosettes and its Analysis.

- **Course Outcomes:** At the end of this course, student will be able to
  i. Apply the concepts of Applied Physics, Analysis of mechanical elements for different mechanical components using ESA Techniques.
  ii. Demonstrate and implement concept of Photo-Elasticity for stress Analysis of Machine Component.
  iii. Understand the properties of different Photo-Elasticity Materials.
  iv. Analyze the principal stress in Mechanical Component using separation Techniques.
  v. Apply the concepts of coating methods to solve Mechanical Engineering related problems.
  vi. Understand the working principal of strain Gauge with its different configuration
  vii. Apply strain Gauge bonding technique on different components to analyze different parameters.

viii. Analyze and implement Rosette Configurations to solve Mechanical problems.

ix. Apply the concepts of Applied Physics, Analysis of mechanical elements for different mechanical components using ESA Techniques.

Section I

Unit 1–Introduction to ESA **No of lectures – 05**

- **Prerequisite:** Knowledge of Applied Physics, Analysis of mechanical elements and Engineering Mathematics
- **Objectives:**
  1. To study optics law for two dimensional photos elasticity
  2. To study various ESA Techniques.
- **Outcomes:** After completing this unit, student will be able to
  1. Analysis of mechanical elements for different mechanical components using ESATechniques
  2. Study three dimensional model of photo elasticity
- **Unit Content:**

a) Principles of Experimental approach

Introduction to ESA, Advantages of ESA techniques, Necessity of various ESA methods, methodology of problem solving by ESA

b) Theory of Photo Elasticity

i) Introduction: Optics related to photo elasticity- Ordinary light, Monochromatic light, polarized light, natural and artificial birefringence.

ii) Stress optic law in two dimensions at normal incidence, material fringe value in terms of stress function.

c) Introduction to Three Dimensional Photo Elasticity

- **Content Delivery Methods:** Board, Chalk and talk

Unit 2–Poloriscope **No of lectures – 06**

- **Prerequisite:** Knowledge of Applied Physics and analysis of mechanical elements, and Engineering Mathematics
- **Objectives:**
  1. To study different types of polarscope and its different arrangement.
  2. To study effect of stressed photo elastic model.
- **Outcomes:** After completing this unit, student will be able to analysis
  1. Plane and circular polar scope and its different arrangement
- **Unit Content:**

Plane polariscope, Circular polariscope, Different arrangements

(a) Effect of stressed model in plane polariscope – Isoclinics, Isochromatics

(b) Effect of stressed model in circular polariscope – Isochromatics

(c) Use of white light and determination of orders of isochromatic fringes seen in the circular polariscope.

(d) Fractional fringe measurement:

(i) Tardy's Method (ii) Babinet Soleil Method.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 3–Photo elastic Materials **No of lectures – 05**

- **Prerequisite:** Knowledge of Material Sciences and Manufacturing Process.
- **Objectives:**
    1. To Study the different photo elastic materials and its property.
    2. To determine material fringe value by using calibration methods.
- **Outcomes:** After completing this unit, student will be able to
    1. Identify different photo elastic materials for any application.
    2. Calculate material fringe constant for photo elastic material.
- **Unit Content:**
    (a) Criterion for selection of model materials.
    (b) Properties of commonly employed photo elastic materials
    (c) Casting technique and machining of model.
    (d) Conclusions pertaining to material selection
    (e) Calibration methods -circular disc, tensile specimen, beam model, Significance of material fringe value
- **Content Delivery Methods:** Board, Chalk and talk

Unit 4–Analysis Techniques **No of lectures – 05**

- **Prerequisite:** Knowledge of Engineering Mathematics, Machine Design
- **Objectives:**
    1. To study isoclinic and isochromatic fringes.
    2. To study different separation techniques for determination Principal stress difference

    (σ1- σ2) at the given point
- **Outcomes:** After completing this unit, student -
    1. To find the Principal Stresses at any point in photo elastic model
    2. To determine the Principal stress at given point in photo elastic model using different separation technique.
- **Unit Content:**

    a) Determination of direction of Principal stresses at given point

    b) Determination of exact fringe order N and the principal stress difference (σ_1- σ_2) at the given point

    c) Separation methods

    • Method based on Hooke's Law• Electrical analogy method• Oblique incidence method

    d) Scaling model results to prototype
- **Content Delivery Methods:** Board, Chalk and talk

Section II

Unit 5– Elementary Treatment **No of lectures – 03**

- **Prerequisite:** Knowledge of Manufacturing Process and Materials
- **Objectives:**
    1. To learn different ESA method.
- **Outcomes:** After completing this unit, student will be able to

1. To Calculate principal stress at given point in Photo elastics model.

- **Unit Content:**

  a) Brittle coating method - merits, demerits and applications.

  b) Working of Reflection Polariscope - merits, applications

- **Content Delivery Methods:** Board, Chalk and talk

Unit 6–Strain Measurement Methods: Electrical Resistance Strain Gauge No of lect. – 06

- **Prerequisite:** Concept of Electric circuit.
- **Objectives:**
  1. To study different strain gauges and its materials.
  2. To study different Configurations of Wheatstone bridge circuit.
- **Outcomes:** After completing this unit, student will be able to
  1. Use Strain Gauges for any application
  2. Determine strain for mechanical component.
- **Unit Content:**

  Introduction, types, construction and material, Gauge factor, cross or transverse sensitivity and error due to it, Introduction to Wheatstone Bridge Circuit, O/P of Wheatstone Bridge Circuit, Different Configurations, Initial Balancing of bridge circuit.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 7 –Strain Gauges No of lectures – 05

- **Prerequisite:** Concept of Machine design and Material Sciences
- **Objectives:**
  1. To study selection of strain gauges and its bonding procedure on Mechanical element.
  2. To Study different load cell.
- **Outcomes:** After completing this unit, student will be able to
  1. Select proper Strain gauges and bonding procedure.
  2. Explain applications of Strain gauges for Measurement of Physical Parameters.
- **Unit Content:**

  a) Selection and Mountings of Strain Gauges: Grid, backing, adhesive, mounting methods, checking gauge installation, Moisture proofing. Strain Gauge Circuitry:

  b) Measurement of force or load, Measurement of torque, Strain measurement of rotating shaft, Measurement of pressure or vacuum.

- **Content Delivery Methods:** Board, Chalk and talk

Unit 8–Computation of Stresses No of lectures – 05

- **Prerequisite:** Knowledge of analysis of mechanical elements and Machine Design
- **Objectives:**
  1. To Study different Strain Gauge Rosettes.
  2. To Study determination of Principal stress by Strain Gauge Rosettes.
- **Outcomes:** After completing this unit, student will be able to

1. To Analysis of principal stress using different Rosettes

- **Unit Content:**

(a) Introduction to Strain Gauge Rosettes, its applications.
(b) Analysis when principal stress directions are known.
(c) Analysis when principal stress directions are unknown.
i) Delta rosette, Tee-rosette, four element rectangular rosette, Rectangular rosette – Two and three element

- **Content Delivery Methods:** Board, Chalk and talk

- **Term Work: (Minimum Eight Experiment of the following)**

1. Sheet casting and preparation of photo elastic model
2. Assignment on isoclinic, iso-chromatics and tardy method.
3. Calibration of photo elastic model material.
4. Separation of stresses using oblique incidence method.
5. Study of moiré fringe technique and brittle coating method.
6. Bonding of Strain Gauge and checking its installation
7. Measurement of Strain and gauge factor for Single arm sensitive bridges
8. Measurement of Strain and gauge factor for two arm and four arm sensitive bridges.
9. Measurement of force using load cell.
10. Measurement of torque using strain gauge circuitry.

- **Text Books:**

1. Experimental stress analysis – Dally and Riley.-McGraw Hill
2. Experimental stress analysis – Dr. Sadhu Singh., Khanna Publications.
3. Experimental stress analysis – L.S.Srinath., Tata McGraw Hill
4. Experimental stress analysis – Dove and Adams
5. The strain gauge primer – Perry Listner.
6. Moiré fringes – Theocoris. Pergamon press limited.
7. Experimental stress analysis – Doyle

- **Reference Books:** Experimental stress analysis – Dally and Riley.-McGraw Hill

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-II
Professional Elective-IV Course-II
ME325 Mechanical Vibration

Teaching Scheme	**Examination Scheme**
Lectures– 3 Hours/week, 3 Credits	**ESE– 70 Marks**
Tutorial – 2 Hour/week, 1 Credit	**ISE –30 Marks**
	ICA- 25 Marks

- **Course Introduction:**
  Vibration is a common phenomenon occurring in a mechanical system. For example, vibration of a rotor due to unbalanced mass, vibration of a vehicle engine at varying speeds. The study of a dedicated course is required to understand the fundamental and advance concepts of mechanical vibrations for engineers and designers. This course is of basic level. It introduces fundamentals of vibration, free and forced, undamped and damped vibration, vibration of single Degree of Freedom (DOF) system, 2-DoF, theory of vibration absorbers and vibration instruments.
- **Course Prerequisite:**
  Student shall have knowledge of Engineering Mechanics, Theory of Machine. A sound background of analysis of mechanical element is essential for successful completion of this course.
- **Course Objectives**: During this course, student is expected
  1 To acquire knowledge of fundamental concepts of mechanical vibration and analysis.
  2 To develop competency in understanding of vibration and noise in Industry.
  3 To develop analytical competency in solving vibration problems.
  4 To understand the various techniques of measurement and control of vibration and noise
- **Course Outcomes**: At the end of this course, student will be able to
  1. Understand the fundamentals of vibration and Noise.
  2. Mathematically model mechanical systems Solve problems on free and forced vibration of one & two degree of freedom systems
  3. Understand measurement and control of vibration and noise.
  4. Design mechanical systems for vibration isolation and measurement
  5. To measure vibrations, vibration characteristics and understand various methods for vibration control for real life problem

Section I

Unit 1–Introduction **No of lectures – 06**

- **Prerequisite:** Knowledge of Theory of Machine and mathematics.
- **Objectives:**
  1. To understand vibration terminology, reparative motion concept.
  2. To understand Fourier transformation.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain different terms used in vibration.
  2. Explain Fourier transformation

- **Unit Content:**

Types of Vibrations, Simple Harmonic Motion (S.H.M), and principle of super position applied to Simple Harmonic Motion, Beats, Fourier theorem.

- **Content Delivery Methods:** Board, Chalk and talk, animations.
- **Assessment Methods:** Questions based on Definition of vibration terminology, types of vibration, SHM, Fourier theorem.

Unit 2–Undamped Free Vibration **No of lectures – 07**

- **Prerequisite:** Knowledge of mathematics and mathematic modeling.
- **Objectives:**
    1. To understand undamped free vibrations.
    2. To calculate natural frequency of free vibration.
    3. To understand simple and compound pendulum.
- **Outcomes:** After completing this unit, student will be able to
    1. Explain degrees of freedom of motion equation.
    2. Calculate natural frequency of undamped free vibration.
- **Unit Content:**

  Single degree of freedom systems, undamped free vibrations natural frequency of free vibration, stiffness of spring elements, effect of mass of spring, Compound Pendulum

- **Content Delivery Methods:** Board, Chalk and talk, animations.
- **Assessment Methods:** Questions based on explanation of stiffness of spring elements, effect of mass of spring, Compound Pendulum. Derivation and numerical on mathematical modeling of physical single degree free vibration system, calculation of equivalent stiffness of spring, natural frequency of system.

Unit 3–Damped Free Vibration **No .of lectures – 06**

- **Prerequisite:** Knowledge of force equilibrium method, materials and mathematics.
- **Objectives:**
    1. To understand various types of damping and its effect.
    2. To understand the damping in physical system.
    3. To calculate damped natural frequency of system.
- **Outcomes:** After completing this unit, student will be able to
    1. Understand various types of vibration dampers.
    2. Derive critical damping required for particular system.
    3. Calculate damped natural frequency, damping coefficient, damping factor, Logarithmic decrement.
- **Unit Content:**

  Single degree freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement

- **Content Delivery Methods:** Board, Chalk and talk, animations.
- **Assessment Methods:**

Questions based on Definitions of terminology used in damped vibration system, types of damping, derivation and numerical on critical damping, natural frequency of single degree damped vibration, Logarithmic decrement.

Unit 4–Forced Vibration **No. of lectures – 07**

- **Prerequisite:** Knowledge of gear, materials and mathematics.
- **Objectives:**
  1. To understand vibrations of system under the application of external force.
  2. To study Complex algebra.
  3. To calculate vibration isolation and transmissibility ratio.
- **Outcomes:** After completing this unit, student will be able to
  1. Apply steady state solution for viscous damping due to harmonic force.
  2. Solve Complex algebra.
  3. Calculate vibration isolation and transmissibility ratio.
- **Unit Content:**

Single degree freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation-transmissibility ratio, due to harmonic excitation and support motion.

- **Content Delivery Methods:** Board, Chalk and talk, animations.
- **Assessment Methods:** Questions based on forced vibration system, derivation and numerical on vibration isolation-transmissibility ratio, due to harmonic excitation and support motion.

Section II

Unit 5–Vibration Measuring Instrument& Whirling of Shaft **No of lectures – 07**

- **Prerequisite:** Knowledge of measurement and instrumentations and mathematics.
- **Objectives:**
  1. To understand working of various motion sensors.
  2. To study of modern methods of vibration measurement.
  3. To calculate critical speed of shafts.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain different types of motion sensors, accelerometers and FFT analyzer.
  2. Understand Whirling of shaft.
  3. Calculate critical speed of given system.
- **Unit Content:** Instruments for measurement of displacement, velocity and acceleration and frequency of vibration, Sensors and Actuators, Introduction of X-Y plotter, FFT analyzer. Whirling of shafts with and without air damping, discussion of speeds above and below critical speeds.

  Content Delivery Methods: Board, Chalk and talk, animations.

  Assessment Methods: Questions based on constriction, working of motion sensors, working of FFT analyzer, X-Y plotter. Derivation and numerical on whirling of shaft and critical speed of shaft.

Unit 6–Two degree of Freedom system **No of lectures – 07**

- **Prerequisite:** Knowledge of materials, forces and mathematics.
- **Objectives:**

1. To understand co-ordinate coupling, generalized and principal co-ordinates.
2. Generate Mathematical modeling of various physical systems
3. To calculate mode shapes and natural frequencies.

- **Outcomes:** After completing this unit, student will be able to
  1. Explain co-ordinate coupling, generalized and principal co-ordinates.
  2. Generate mathematical model of physical systems like bicycle, motorcycle for vibration analysis
  3. Calculate mode shapes and natural frequencies.
- **Unit Content:** Introduction, principal modes and normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, free vibration in terms of initial conditions. Geared systems. Introduction to Physical and Mathematical modeling: Bicycle, Motor bike and Quarter Car.

  Content Delivery Methods: Board, Chalk and talk, animations.

  Assessment Methods: Questions based on co-ordinate coupling, generalized and principal co-ordinates, derivation and numerical on Mathematical modeling and mode analysis.

Unit 7–Introduction to Numerical Method **No of lectures – 06**

- **Prerequisite:** Knowledge of mathematics.
- **Objectives:**
  1. To understand use of Numerical Methods in Vibration.
  2. To understand Holzer method, Rayleigh method, Matrix iteration method.
- **Outcomes:** After completing this unit, student will be able to
  1. Identify suitable numerical method to solving vibration problem. .
  2. Explain Holzer method, Rayleigh method and Matrix iteration method.

- **Unit Content:** Introduction to Numerical Methods in Vibration, Holzer method, Rayleigh method, Matrix iteration method.

  Content Delivery Methods: Board, Chalk and talk, animations.

  Assessment Methods:

  Questions based derivation and numerical on Holzer method, Rayleigh method, Matrix iteration method.

Unit 8–Introduction to Noise **No of lectures – 06**

- **Prerequisite:** Knowledge of instrumentation and mathematics.
- **Objectives:**
  1. To understand terminology used in noise analysis.
  2. To understand relation among sound power, Sound intensity & sound pressure level and octave band analysis.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain terminology used in noise analysis
  2. Explain Decibel scale, Relation among sound power, Sound intensity & sound pressure level.
- **Unit Content:**

Sound level & subjective response to sound, Frequency dependent human response to sound, Sound pressure dependent human response Decibel scale, Relation among sound power, Sound intensity & sound pressure level, Octave band analysis.

- **Content Delivery Methods:** Board, Chalk and talk, animations.
- **Assessment Methods:**

  Questions based on Definition used in sound analysis, frequency dependent human response to sound, Sound pressure dependent human response Decibel scale, Relation among sound power, Sound intensity & sound pressure level and Octave band analysis.

Term Work:

PART-A

1. To determine the natural frequency of damped vibration of single degree freedom system and to find it‘s damping coefficient.

3. To obtain frequency response curves of single degree freedom system of vibration for different amount of damping.

PART-B

1. To determine critical speed of shaft with single rotor.
2. To verify natural frequency of torsional vibration of two rotor system and position of node.
3. Experimental verification of principle of dynamic vibration absorber.

PART-C

1. Determination of free response of SDOF damped system to demonstrate different damping Conditions using suitable software.
2. Determination of total response of SDOF damped system to harmonic excitation using suitable Software.

- **Text Books:**

1. Rao S. S. —Mechanical Vibrations, Pearson Education Inc. New Delhi.
2. Grover G. K. —Mechanical Vibrations, New Chand and Bros. Roorkee
3. Wiiliam J Palm III, —Mechanical Vibration Wiley India Pvt. Ltd, New Delhi
4. UickerJ.John, Jr, Pennock Gordon R, Shigley Joseph E.—Theory of Machines and Mechanisms International Version, OXFORD University Press, New Delhi.
5. M L Munjal, — Noise and Vibration Control Cambridge University Press India

- **Reference Books:**

1. Weaver- Vibration Problems in engineering 5th Edition Wiley India Pvt. Ltd, New Delhi.
2. Bell, L. H. and Bell, D. H., Industrial Noise Control – Fundamentals and Applications, Marcel Dekker Inc.
4. DrDebabrata Nag,-Mechanical Vibrations, Wiley India Pvt. Ltd, New Delhi.
5. Kelly S. G. Mechanical Vibrations, Schaum’s outlines, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
6. Meirovitch,-Elements of Mechanical Vibrations‖, McGraw Hill

Solapur University, Solapur
T.E. (Mechanical Engineering) Semester-II
Professional Elective-IV Course-III
ME325 Tool Engineering

Teaching Scheme
Lectures – 3 Hours/week, 3 Credits
Tutorial – 2 Hour/week, 1 Credit

Examination Scheme
ESE– 70 Marks
ISE –30 Marks
ICA- 25 Marks

- **Course Introduction**:
  This course seeks to provide an introduction to tool engineering and discusses various procedures, requirements, tooling methods. It introduces engineering materials and describes the different kinds of tools, jig & fixture used in industries. A further content explains in detail the design of press tool draw tool jig & fixture as well as tool nomenclature and geometry.

- **Course Prerequisite:**
  Student shall have knowledge of function of press tool and draw tool, cutting tools and theory of metal cutting etc.

- **Course Objectives:**
  1. To enlighten the students about the basics in mechanics of cutting & non cutting operations.
  2. To explain the concepts, principles & practices in designing various tools.
  3. To explain the students about the basics in economics of cutting & non cutting operations.
  4. To explain the concepts, principles & practices in designing various tooling.

- **Course Outcomes:**
  1. Students are able to do the calculations involved in the mechanics & economics of operations.
  2. Students are able to design & draw the tools & tooling for the given situation & operation.
  3. Students are able to conceive & develop solutions, devices, contrivances to overcome present problems of the real world.

Section I

Unit 1–Theory of metal cutting. **No of lectures – 03**

- **Prerequisite:** Knowledge of trigonometric as well as subject like mathematics and applied mechanics and strength of material.
- **Objectives:**
  1. To work on theory of metal cutting to decide the power requirement.
  2. To study of cutting fluid tool material and tool dynometer.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain/ the power requirement in the metal cutting
  2. Select the proper tool material and cutting fluid in the metal cutting.
- **Unit Content:**
  a) Orthogonal cutting & oblique cutting, Force analysis for orthogonal cutting
  b) Chip formation, types of chips, wedge action, shear plane angle, cutting ratio, shear stress & strain, velocity relationship, Merchants theory, Merchants circle & force relationship
  c) Tool dynamometers- types, applications.
  d) Machinability Index, factors affecting machinability
  e) Tool life- Flank & crater wear, effect of variables on tool life, Taylor's equation of tool life
  f) Coolants- Heat generation, types of coolants.
  g) Tool Materials

- **Content Delivery Methods:** Board, Chalk and talk

Unit 2- Press Tools **No of lectures – 06**

- **Prerequisite:** Knowledge of press tool and draw tool forming process
- **Objectives:**
  To carry out design of press tool & draw tool.
- **Outcomes:** After completing this unit, student will be able to design.
  Design of press tool & draw tool.
- **Unit Content:**
  a) Elements of press tools, types of dies, types of operations.
  b) Design of die for cutting operation, mechanics of shearing, cutting force estimation, punch & die clearance, stock strip lay out, design of punches & die block functioning & place of other elements. Centre of pressure, selection of die set & press
  c) Design of drawing dies, determination of blank size, no. of draws, stage wise component drawing, drawing radii, clearance, estimation of drawing force, time & power
  d) Types of Bending dies, related estimates.
- **Content Delivery Methods:** Board, Chalk and talk

Unit 3– Geometry & Nomenclature of cutting tools **No of lectures – 06**

- **Prerequisite:** Design of cutting tool and material for cutting tool
- **Objectives:**
  1.To know about Geometry of cutting tool
  2.To know about use of various angle and its applications
- **Outcomes:** After completing this unit, student will be able to
  1.Decide the cutting tool for particulars material
  2.Decide the importance of various angle on cutting tool
- **Unit Content:**
  a) Single point cutting tools- Geometry & Tool signature as per ASA system & ORS system, effect of geometry on tool life, cutting force, surface finish.
  b) Types of Multipoint cutting tools like Milling cutters, Drills, Broaches, Reamers
- **Content Delivery Methods:** Board, Chalk and talk

Unit 4– Design of Jigs & Fixtures. **No of lectures – 05**

- **Prerequisite:** Concepts of engineering drawing, machine drawing and machine design.
- **Objectives:**
  1. To decide the locating devices.
  2. To decide clamping devices.
- **Outcomes:** After completing this unit, student -
  1. Should design jog & fixture.
  2. Should design jig and fixture fool proffer.
- **Unit Content:**
  Introduction, necessity & applications, basic concepts
  b) Location & clamping systems- Principle, types, applications
  c) Design of Jigs- Principles of Jig design, types &applications, types of bushes &selection, use of standard parts, design procedure & drawing.
  d) Design of Fixtures- Principles of Fixture design, standard elements & types of fixtures, design of milling fixtures.
- **Content Delivery Methods:** Board, Chalk and talk

Section II

Unit 5– Economics of Tooling **No of lectures – 03**

- **Prerequisite:** Knowledge of engineering management and industrial engineering
- **Objectives:**
  To learn about cost profit EOQ and tool replacement policy
- **Outcomes:** After completing this unit, student will be able to
  To calculate cost and after adding profit decide the sales prize.
- **Unit Content:**
  a) Elements of cost: methods of depreciation
  b) Estimation of total cost & sales price
  c) Break- even analysis for equipment selection
  d) Economics of small tool selection, equipment replacement
  e) Economic Order Quantity for Batch production
- **Content Delivery Methods:** Board, Chalk and talk

Term Work:

(Minimum Six of the following)

1. Study of cutting tools: Classification, Nomenclature, and Geometry
2. Exercise on Theory of metal cutting.
3. Demonstration of Lathe tool & Drill tool dynamometer & calculation of cutting forces.
4. Exercises on Mechanics & Economics of Machining & Tooling
5. Sheet on Press tool design- Cutting & drawing operation, necessary calculation
6. Sheet on Jig design- Exercise & drawing
7. Sheet on Fixture design- Exercise & drawing
8. Industrial visit

• Text Books:

1. Text Book of Production Engineering – P.C.Sharma (S.Chand Publication)
2. Machine Tool Engineering – G.R. Nagpal (khanna Publication)
3. Press Tools – P.H.Joshi (S.Chand Publication)
4. Jigs & Fixtures - P.H.Joshi (S.Chand Publication)

• Reference Books:

1. Metal cutting Theory & tool design- Mr. Arshinnov (MIR Publication)
2. Fundamentals of Tool design- ASTME Publication
3. Tool design – Donaldson (TMH Publication)
4. Jig & Fixture Design – Kempster (ELBS Publication)
5. Die Design Fundamentals-J.R.Paquin

TE (Mech) Part- II
6.0 Advanced Computing Techniques – II
ME327 (SCILAB)

Teaching Scheme	**Examination Scheme**
Theory: 1 hour week	**University Exam: Nil**
Practical: 2 hours week	**ICA: 50 Marks**

Course Introduction: This course emphasizes the fundamentals of various topics under Scilab necessary for providing a numerically computing environment scripts with respect to mechanical applications. It contains basic concepts of Scilab which is helpful in developing programs in specialized areas of technology, mathematics,statistics.It covers the topics like Introduction to Scilab,Scalars,Vectors, Matrices, Mathematical functions and operations, Operators, Control Structures, Plotting, Statistical Operations, Image Processing and Scicos Toolbox.

- **Course Objectives:**

1. To learn the basic syntax Scilab and use the mathematical functions in Scilab.
2. To make students familiar with the general programming concepts of Scilab such as variables branching loops and functions.
3. To make the students familiar the scope and applications 2D and 3D graphs in SCILAB.
4. To develop simple codes for Statistics and Image Processing.

- **Course Outcomes:** A student who has successfully completed this course must be able to accomplish the following tasks;

1. Solve mathematical problems using Scilab and Plot 2D and 3D curves for mathematical problems.
2. Write Scilab code for various statistical applications.
3. Write Scilab Code for simple Image processing problems.
4. Use Scicos to solve simple transfer function control problems.

Unit – 1 Introduction **No. of lectures -01**

- **Prerequisites:** Operate a computer, basic understanding of programming
- **Objectives:**

To introduce the student about the history of Scilab and installation of the software..
To make the student know about the menu bar of Scilab software.

- **Outcomes:** After completing this unit, a student can

Install the software and explain about the history of Scilab.
Explain the different menu bar of Scilab.

- **Unit Content:**

Installing Scilab in Windows and Linux, history of Scilab, Scilab vs. Matlab, working directory, Scilab commands, menu bar, and toolboxes.

Unit – 2 Scalars and Vectors and Matrices **No. of lectures -02**

- **Prerequisites:** Basic mathematics

- **Objectives:**
  1. To introduce the student about the concept of Scalars and Vectors.
  2. To make the student know about the different operators which are used to performing different mathematical operations
- **Outcomes:** After completing this unit, a student can
  Explain the concept of Scalars and Vectors
  Use different operators to perform different matrix operations.
- **Unit Content:** Mathematical operations on vectors, relational operations on vectors, logical operations on vectors, arithmetic operations on matrices, basic matrix operations such as inverse, triangular form, transpose and Eigen values.

Unit – 3 Mathematical Functions and operations **No. of lectures -03**

- **Prerequisites:** Basic mathematics - logic, trigonometry, algebra
- **Objectives:**
  1. To introduce the student about the different mathematical functions.
  2. To make the student know about the process of creating complex numbers and polynomials.
- **Outcomes:** After completing this unit, a student can
  1. Perform different mathematical operations using functions.
  2. Perform different operations on complex numbers and polynomials.
- **Unit Content:**
  Elementary mathematical functions, logical functions, functions on scalars, trigonometric functions, hyperbolic functions, complex numbers, creating polynomials finding root of polynomials

Unit – 4GeneralProgramming **No. of lectures -02**

- **Prerequisites:** Concepts of programming
- **Objectives:**
  1. To introduce the student about taking the input and printing the output.
  2. To make the student know about the application of different control statements.
- **Outcomes:** After completing this unit, a student can
  1. Develop program for taking input from user and thereby print the output.
  2. Develop scripts using different control statements.
- **Unit Content:**
  Variables, arithmetic, relational and logical operators, input – output, branching & conditional statements, scripts, functions, and user defined functions.

Unit - 5.Graphical Plotting **No. of lectures -02**

- **Prerequisites:** Concepts of data representation
- **Objectives:**
  1. To introduce the concepts of different plots.
- **Outcomes:** After completing this unit, a student can
  Create different plots.
- **Unit Content:** Menus, executing menus from command line, code linking, dialog boxes. 2D

plots, 3D plots, line and polygon plotting, rectangle plotting and arc plotting.

Unit - 6.StatisticalOperations **No. of lectures-02**

- **Prerequisites:** Concepts of Statistics
- **Objectives:**
  1. To introduce the student about the concept of different distribution in statistics.
  2. To make the student know about the Fischer test.
- **Outcomes:** After completing this unit, a student can
  1. Create different distribution in Scilab.
  2. Explain the Fischer test.
- **Unit Content:** Basic statistical functions, distributions, correlation, central moment, covariance, frequencies and percentiles, Fischer test, sampling, Lab stat toolbox.

Unit – 7 Image Processing **No. of lectures-01**

- **Prerequisites:** Concepts of Image Processing
- **Objectives:**
  1. To introduce the student about the fundamentals of Image Processing.
  2. To make the student know about the different image processing functions.
- **Outcomes:** After completing this unit, a student can
  1. Explain different fundamentals of Image Processing.
  2. Manipulate the image by applying functions.
- **Unit Content:** Fundamentals of Image Processing, basic image processing functions such arithmetic, filters, edge detection, noise removal.

Unit - 8.ScicosToolbox **No. of lectures -01**

- **Prerequisites:** Concepts of C & C++
- **Objectives:**
  1. To introduce the student about the history and features of Java.
  2. To make the student know about the process of installation of Java software.
  3. To make the student to develop a simple Java program.
- **Outcomes:** After completing this unit, a student can
  1. Install the java software.
  2. Develop a simple java program.
- **Unit Content:** Basic control theory, defining and simulating transfer functions.
- **Term work**

  Computing Assignments
  1. Exercises on Vector Operations.
  2. Exercises on Matrix Operations
  3. Exercises on branching and conditional statements.
  4. Assignment on User Defined Functions and scripts.
  5. Exercises involving 2Dplots.
  6. Exercises involving 3Dplot.
  7. Exercises on statistics.
  8. Exercises on filtering and image arithmetic using the image processing toolbox.

9. Exercises on transfer functions using Scicos
10. A complex problem involving several functions and operations.

- **Text Books**
  1. SCILAB Hema Ramchandran S.Chand
  2. SCILAB by Example M. AffoufPaperback
  3. Programming with SCILAB Vinu Das New Age International
- **List of Reference Books**
  1. Modelling and Simulation in SCILAB/SCICOS Stephen Cambell Springer
  2. Engineering and Scientific Computing with SCILAB Claude Gomez Birkhauser
  3. SCILAB: Introduction, applications and more Gaby Alez Websters
  4. Scilab Jesse Russel Bookvika
  5. Scilab Lambert Surhone BetaScript

T.E. (Mechanical) Part – II
ME328 Workshop Practice – V

Teaching Scheme	Examination Scheme
Practical- 2hrs/week	ICA– 25 Marks
Practical Exam- duration- 6 Hrs.	POE -50Marks

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Course Objective:

1) To make the students aware with various skills involved in manufacturing &Assembly.

2) To develop skills to operate different machine tools.

3) To make the students aware of limits, fits & tolerance while manufacturing assembly.

4) To make students aware of operation sequence, speed feed selection for different materials & Operations

Course Outcomes:

1) To create confidence amongst the students in Production / manufacturing activities.

2) Students should get experience about manual skills required to perform machining operations.

3) To create confidence in students while designing limits, fits & tolerances during manufacturing.

4) To create awareness in students regarding time management, work study, method study & tool Engineering

1. A composite job consisting of three components machined from Φ32 mm MS bar. (Excluding commercial components) requiring minimum five operations listed below:

1. Turning 2. Drilling 3. Boring 4. Hand tapping 5. Milling 6. Internal & External V-threading 7. Grinding

2. T. E. (Mechanical Engineering) Syllabus w.e.f. 2016-17 2. The components of the composite job shall carry at least two specified close tolerance operations. In addition to the above, following operations are to be demonstrated during the term. (These are not to be included in the job operations for term work & exams.)

1. Shaping 2. Slotting 3. Grinding 4. Form Turning 5. Knurling 6. Grooving

3. Journal should contain detailed process sheet of above job.

4. Assessment of Workshop Practice-IV-Term work shall be done for 50 % Work or one major Component & Workshop Practice-V-Term work shall be done for remaining work at the end of T.E. (Mech.) Part II.

5. Practical examination of 6 Hrs. duration having component of 2 to 3 parts.

Note: Material specification for practical work & examination is raw material Φ32mm M.S. bar.

Books:

1. Workshop Technology (Volume II) by Raghuvanshi.
2. Workshop Technology (Volume II) by HajraChowdhary.
3. Workshop Technology (Volume II) by W.A.J.Chapman.

Reference Books:

1. Production Technology by P.C.Sharma.
2. Production Technology – HMT Handbook.
3. Production Technology (Volume II) by Gupte-Patel.
4. H Gerling, All about Machine Tools, New Age International, 1995.

SELF LEARNING COURSES (TECHNICAL)

Solapur University, Solapur

T.E. (Mechanical Engineering) Semester-II

Technical Self Learning Course I

ME326 Renewable Energy Sources

Teaching Scheme
Self Learning – 2 Credits

Examination Scheme
Theory Paper (ESE) – 50 Marks

Course Introduction: The course is designed to familiarize and train the student with the tools and techniques used to assess the various renewable energy resources and its potential at any location across the globe, so that a student is able analyze a case quantitatively after completion of the course.

Course Prerequisite: Student shall have basic knowledge of various nonconventional energy sources such as solar, wind, biomass, geothermal energy, ocean etc. as a source of energy.

Course Objectives: During this course, student is expected

1 Describe the principles of operation of the broad spectrum of renewable energy technologies.

2 To outline utilization of renewable energy sources for both domestic and industrial applications

3 To analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.

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

1 Describe the environmental aspects of non-conventional energy resources in comparison with various conventional energy systems, their prospects and Limitations.
2 Understand various renewable energy technologies and systems.
3 Compare the advantages and disadvantages of various renewable energy technologies and propose the best possible energy conversion system for a particular location.
4 Recognize the need and ability to engage in lifelong learning for further developments in this field

Section I

Unit 1– Introduction to Energy Sources:

- **Prerequisite:** Basic knowledge of conventional, non-conventional energy sources.
- **Objectives:**
  1. To classify the energy sources.
  2. To study world energy futures.
  3. To know the world's energy production & reserves of commercial energy sources.

- **Outcomes:** After completing this unit, student will be able to
  1. Explain different types energy sources
  2. Explain world's energy production & reserves of commercial energy sources.
- **Unit Content:** Types of Energy Sources- Conventional, Non-Conventional, Energy Consumption as a Measure of Prosperity, World Energy Futures, World's Production & Reserves of Commercial Energy Sources, India's Production & Reserves.
- **Content Delivery Methods:** Board, Chalk and talk and PPT

Unit 2– Principles of Solar Radiation:

- **Prerequisite:** Basic knowledge of solar as a source of energy
- **Objectives:**
  1. To know beam & diffused radiation.
  2. To study solar radiation measurements instruments.
- **Outcomes:** After completing this unit, student will be able to
  1. Illustrate the beam & diffused radiation.
  2. Explain construction & working of Pyrheliometer, Pyranometer.
- **Unit Content:** Solar Constant, Beam & Diffused Radiation, Solar Radiation Geometry,

Various angles used, Solar Radiation Measurements- Construction & Working of Pyrheliometer, Pyranometer.

- **Content Delivery Methods:** Board, Chalk and talk and PPT

Unit 3– Solar Energy Collectors:

- **Prerequisite:** Basic knowledge of solar as a source of energy
- **Objectives:**
  1. To study different types of solar collector
- **Outcomes:** After completing this unit, student will be able to
  1. Illustrate different types of solar collector.
  2. List advantages & disadvantages various solar collectors.
- **Unit Content:** Types of Solar Collectors, Flat Plate Collector, Concentrating type Collector, Advantages & Disadvantages, Energy Balance Equation & Collector Efficiency.
- **Content Delivery Methods:** Board, Chalk and talk and PPT

Unit 4– Solar Energy Storage & Applications:

- **Prerequisite:** Basic knowledge of solar as a source of energy.
- **Objectives:**
  1. To know various methods of solar energy storage.
  2. To study various applications of solar energy.
  3. To study Solar Cell

- **Outcomes:** After completing this unit, student will be able to
  1. List the various methods of solar energy storage.
  2. Illustrate the various applications of solar energy.
  3. Explain working principal of Solar Cell.
- **Unit Content:** Different Methods of Solar Energy Storage, Sensible heat storage, Latent heat storage, Solar Ponds. Applications of Solar Energy:- Thermal applications such as Solar Water Heater, Space Cooling, Solar Distillation, Solar Pumping & Solar Cooking. Solar Photo-Voltaic, Solar Cell Principles, Conversion Efficiency, Current-Voltage Characteristics.
- **Content Delivery Methods:** Board, Chalk and talk, PPT

Section II

Unit 5– Wind Energy:

- **Prerequisite:** Basic knowledge of wind as a source of energy.
- **Objectives:**
  1. To learn basic components of wind energy conversion system
  2. To study classification, advantages & disadvantages of wind energy conversion systems
- **Outcomes:** After completing this unit, student will be able to
  1. Explain basic components of wind energy conversion system.
  2. Classify wind energy conversion systems.
  3. List advantages & disadvantages of wind energy conversion systems
- **Unit Content:** Introduction The Power in the Wind, Maximum Power, Betz Coefficient, Basic Components of Wind Energy Conversion System (WECS), Site Selection Consideration, Classification of WCE Systems, Advantages & Disadvantages of WECS. Environmental Aspects.
- **Content Delivery Methods:** Board, Chalk and talk, PPT

Unit 6 – Biomass:

- **Prerequisite:** Basic knowledge of biomass as a source of energy.
- **Objectives:**
  1. To study direct & indirect methods biomass energy.
  2. To know Biogas Plant & its classification.
- **Outcomes:** After completing this unit, student will be able to
  1. Illustrate direct & indirect methods biomass energy.
  2. Explain Biogas Plant & its classification.
- **Unit Content:** Energy from Biomass:- Direct & Indirect Methods, Biomass Gasification, Biogas Plant. Classification of Biogas plant, Its advantages & Disadvantages, Types of Biogas Plant.
- **Content Delivery Methods:** Board, Chalk and talk, PPT

Unit 7– Geothermal Energy:

- **Prerequisite:** Basic knowledge of geothermal energy.
- **Objectives:**
  1. To learn various resources of geothermal energy.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain various resources of geothermal energy.
- **Unit Content:** Typical Geothermal Field, Potential of Geothermal Resources in India, Resources of Geothermal Energy such as Hydrothermal convective systems , Geopressure Resources, Petro-Thermal or Hot Dry Rocks (HDR) & Megma Resources.
- **Content Delivery Methods:** Board, Chalk and talk, PPT

Unit 8 – Ocean Energy:

- **Prerequisite:** Basic knowledge of ocean as a source of energy.
- **Objectives:**
  1. To study various methods of ocean thermal electric power generation.
  2. To know the basic principal of tidal power generation.
- **Outcomes:** After completing this unit, student will be able to
  1. Illustrate various methods of ocean thermal electric power generation.
  2. Explain the basic principal of tidal power generation.
- **Unit Content:**

  Ocean Thermal Energy Conversion (OTEC):

  Introduction, Methods of Ocean Thermal Electric Power Generation, Open & Close Cycle OTEC System,

  Tidal Energy:

  Basic Principal of Tidal Power, Operation Methods of Utilization of Tidal Energy, Single Basin Arrangement, Double Basin Arrangement, Advantages & Limitations of Tidal Power Generation, Tidal Power Potential in India
- **Content Delivery Methods:** Board, Chalk and talk, PPT

- **Text Books:**

1. G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, 4th edition, New Delhi.
2. S.P. Sukhatme, “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., New Delhi.

- **Reference Books:**

1. G. N. Tiwari, M. K. Ghosal, “Renewable Energy Resources: Basic Principles and Applications”, Alpha Science International, 2005
2. Ashok Desai V, “Non-Conventional Energy”, Wiley Eastern Ltd, 1990.
3. K.M. Mittal, “Non-Conventional Energy Systems”, A H Wheeler Publishing Co Ltd.

Solapur University, Solapur

T.E. (Mechanical Engineering) Semester-II

Technical Self Learning Course II

ME326 Industrial Product Design

Teaching Scheme	**Examination Scheme**
Self Learning – 2 Credit	**Theory Paper (ESE) – 50 Marks**

Course Introduction: Industrial Product Design introduces students to the world of industrial design, its dynamics, and different technological equipment involved in the process of designing. The key learning areas of the program are principles of design, balance, framework, movement, editing images, and team management skills. During the program candidates usually deal with products and its design. Industrial product design, as a field of design discipline, borrows concepts and methods from other disciplines, one of which is engineering, in order to develop its own knowledge in research and industry contexts. In the means of strengthening its place among other disciplines, a concentration on 'designerly' ways of knowing, thinking and acting should be provided. Therefore, in this study, the intersection between industrial product design field and engineering discipline is searched for revealing the engineering concepts and non-intuitive design methods within intuitive design methods used in industrial product design. Engineering design field is stated, since its being close to industrial product design, and a comparison is made between industrial product design and some engineering fields through their approach to design problems and the tools they use. Engineering design methods are stated and their advantages in design activity are revealed. This study is a part of design systems area, with formal approaches to models of design processes and knowledge.

Course Prerequisite: Student shall have knowledge of various products, design fundamentals, Engineering drawing and free hand sketching.

Course Objectives: During this course, student is expected

1 To study the basic concepts of product design and development process.

2 To study the applicability of product design and development in industrial applications

3 To study the key reasons for design or redesign.

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

1 Select an appropriate product design and development process for a given application

2 Choose an appropriate ergonomic for the product.

3 Choose an appropriate aesthetics for the product.

4 Select an appropriate standardization method.

5 Develop the methods to minimize the cost.

Section I

Unit 1– Introduction to product design.

- **Prerequisite:** Knowledge of products and machine drawing.
- **Objectives:**
  1. To classify the products.
  2. To study design process.
  3. To know the methods of innovative thinking.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain/Apply Design Process
  2. Think innovatively for product design.
- **Unit Content:** Classification/ Specifications of Products, Product life cycle. Product mix, Modern product development process, Innovative thinking Creative techniques and tools for Concept generation, concept evaluation.
- **Content Delivery Methods:** Board, Chalk and talk and PPT

Unit 2–Conceptual Design

- **Prerequisite:** Knowledge of machine drawing, material properties.
- **Objectives:**
  1. To develop a concept related to product.
- **Outcomes:** After completing this unit, student will be able to design.
  1. Describe the procedure of Industrial Product Design..
- **Unit Content:** Generation, selection & embodiment of concept, Product architecture, Industrial design: process, need. Difference between Product development and product design
- **Content Delivery Methods:** Board, Chalk and talk and PPT

Unit 3–Value Engineering

- **Prerequisite:** Design of machine elements against static load
- **Objectives:**
  1. To carry out value analysis of product
  2. To carry out qualitative and quantitative analysis.
- **Outcomes:** After completing this unit, student will be able to
  1. Value analysis of a product
- **Unit Content:** Value Analysis. : Definition, Methodology. Economic analysis: Qualitative & Quantitative, Product Study and market study, Evaluation tools and techniques.
- **Content Delivery Methods:** Board, Chalk and talk

Section II

Unit 4–Creativity

- **Prerequisite:** Knowledge of creative thinking.
- **Objectives:**
  1. To learn identification of problem in existing product.
  2. To learn techniques to improve creativity
- **Outcomes:** After completing this unit, student will be able to
  1. Identify the problems in logical manner.
  2. Improve the creativity.

- **Unit Content:** Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design. Need and problem identification, Creative techniques and tools for Concept generation, concept evaluation
- **Content Delivery Methods:** Board, Chalk and talk**,** PPT

Unit 5– Aesthetics

- **Prerequisite:** Knowledge of color shape and size, drawing..
- **Objectives:**
  1. To learn concepts of aesthetics
  2. To increase aesthetic value in product
- **Outcomes:** After completing this unit, student will be able to
  1. Use aesthetic concepts in product design
  2. Design product with emotional aesthetics
- **Unit Content:** Concepts of size and texture, colour .Comfort criteria. Philosophical study of beauty and taste. Emotional, *Pitch, Beat, Repetition, Melody, Pattern,* Material aesthetics**,** Design for aesthetic pleasure, Balancing aesthetics and usability, Usability over aesthetics
- **Content Delivery Methods:** Board, Chalk and talk, PPT

Unit 6 –Ergonomics

- **Prerequisite:** Human and man relationship.
- **Objectives:**
  1. To learn man machine relationship.
  2. To use the anthropometry in design..
- **Outcomes:** After completing this unit, student will be able to
  1. Design a product with ease of use.
  2. Use anthropometric data in design..
- **Unit Content:** Gross human autonomy, Anthropometry, Man-Machine interaction, Importance of Human factors in product design, Physical Ergonomics principles and issues
- **Content Delivery Methods:** Board, Chalk and talk, PPT

- **Text Books:**

1) ", Product Design and Development" Karl Ulrich, Steven Eppinger Indian edition, McGraw Hill.
2) David G Ullman, "The Mechanical Design Process." McGraw hillI nc Singapore 1992 N J M Roozenberg , J Ekels , N F M Roozenberg " Product Design Fundamentals and Methods ." John Willey & Sons 1995.

- **Reference Books:**

3) Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and new Product Development." 1 / e 2004, Pearson Education New Delhi
4) Hollins B & Pugh S "Successful Product Design." Butter worths London
5) Bralla J G "Handbook of Product Design for Manufacture, McGraw hill New York

Solapur University, Solapur

T.E. (Mechanical Engineering) Semester-II

Technical Self Learning Course III

ME326 Composite Materials

Teaching Scheme

Self Learning – 2 Credits

Examination Scheme

Theory Paper (ESE) – 50 Marks

Course Introduction:

This course aims at introducing basics of composite materials. Rapid technological advances in engineering brought the scientists and engineers to a point, where they became limited by the capabilities of traditional materials. With the limits of the technology pushed, the materials failed to answer the requirements of the designers or manufacturers. Researchers in materials technology are constantly looking for solutions to provide stronger, durable materials which will answer the needs of their fellow engineers. Composite materials are one of the most favored solutions to this problem in the field. By combining the stronger properties of traditional materials and eliminating the disadvantages they bear, composite materials technology is providing compromising solutions and alternatives to many engineering fields. Problems born from material limitations like heavy weight, structural strength, and thermal resistance are being solved by the composite material alternatives, and many more alternatives are being introduced to readily use engineering applications

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Course Prerequisite:

Student shall have knowledge of materials sciences, Engineering Materials, fundamentals of design and Manufacturing Process.

Course Objectives: During this course, student is expected

1. To know which are various types of composite materials and their applications.

2. To know the properties of composite materials.

3. To know various manufacturing processes of composites.

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

1. Students will understand advantages and limitations of composite materials as competing material to conventional materials.

2. Students will be able to evaluate strength and mechanical properties of composite material.

3. Students will understand different manufacturing methods of composite material and effect of various manufacturing parameters on mechanical properties of composite materials.

4. Students will be able to design simple machine components or structures made of composite materials

Section I

Unit 1–Introduction to Composite Materials

- **Prerequisite:** Basic Knowledge of materials sciences, Engineering Materials.
- **Objectives:**
  1. To classify different composite Materials.
  2. To study different composite Materials.
  3. To know various application of Composite Materials.
- **Outcomes:** After completing this unit, student will be able to
  1. Explain/Apply to select proper Engineering materials for engineering application
- **Unit Content:** Definition, Classification, Types of matrix materials and reinforcements, Characteristics & selection, Fiber composites, types fibrous laminated composites, Metal matrix composite, Particulate composites and Pre-pegs, Application of Composite Materials.
- **Content Delivery Methods:** Board, Chalk and talk and PPT

Unit 2–Mechanical Behavior of Lamina-

- **Prerequisite:** Knowledge of Strength and Analysis of Mechanical Element.
- **Objectives:**
  1. To Analysis of Mechanical component for different Engineering application.
- **Outcomes:** After completing this unit, student will be able to design.
  1. Analysis and design of composite materials.
- **Unit Content:** Anisotropy, orthotropy, stiffness, engineering constants, uniaxial and biaxial strength of lamina, failure theories maximum stress, maximum strain, TsaiHill, Hoffman, TsaiWu, computational procedure, applicability, mechanics approach to stiffness and strength
- **Content Delivery Methods:** Board, Chalk and talk and PPT

Section II

Unit 3–Manufacturing: Lay- up and curing

- **Prerequisite:** Knowledge of Engineering materials and manufacturing process for composite materials.
- **Objectives:**
  1. To study and select manufacturing process for composite materials.
- **Outcomes:** After completing this unit, student will be able to
  1. To understand the different manufacturing process for composite materials.
- **Unit Content:** open and closed mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Types of defects.
- **Content Delivery Methods:** Board, Chalk and talk and PPT

Unit 4– Introduction to Design of Composite Structures

- **Prerequisite:** Knowledge of theory of failure and Design of Machine Element
- **Objectives:** To study design concept of Composite Structures
- **Outcomes:** After completing this unit, student will be able to
  1. To study and analysis of design parameters of composite structure
- **Unit Content: Introduction to Design of Composite Structures**
- **Content Delivery Methods:** Board, Chalk and talk, PPT

Reference Books:

1. Mechanics of Composite Materials, R.M. Jones, Taylor & Francis.
2. Mechanics of composite materials, Autar K. Kaw, CRC Press New York.
3. Composite Materials handbook, Mein Schwartz, Mc Graw Hill Book Company, 1984.

Reference Books:

1. Stress analysis of fiber Reinforced Composite Materials, Michael W, Hyer, Mc-Graw Hill International.
2. Composite Material Science and Engineering, Krishan K. Chawla, Springer. Fiber Reinforced Composites, P.C. Mallik, Marcel Decker

Solapur University, Solapur

T.E. (Mechanical Engineering) Semester-II

Technical Self Learning Course IV

ME326 Non-Conventional Machining Processes

Teaching Scheme
Self Learning – 2 Credit

Examination Scheme
Theory Paper (ESE) – 50 Marks

Course Introduction: The course aims at introducing basics of non-conventional machining. It also intends to cover various non-conventional machining processes with their applications. The course acquaint about operating principal, advantageous and limitations of non-conventional machining. Itintroduces large number of non-conventional machining processes on practical aspects. Variousaspects of non-conventional machining are also discussed so that student will be ableto make use of non-conventional machining processes for different applications.

Course Prerequisite: Students have completed a comprehensive course in basic mechanical engineering and Machine tool processes, and shall have anunderstanding of conventional machining processes. Student also has knowledge of material removal in conventional machining processes.

Course Objectives:

1. To introduce student about fundamentals of Non-conventional machining processes.
2. To classify the different types of Non-conventional machining processes.
3. To compare between conventional and Non-conventional machining processes.
4. To recognize the applications of different Non-conventional machining processes.

Course Outcomes:

After completion of this unit, students will be able to -

1. Describe fundamentals of Non-conventional machining processes.
2. Classify different types of Non-conventional machining processes.
3. Compare conventional and Non-conventional machining processes.
4. Identify and make use of different Non-conventional machining processes.

Section I

Unit 1-Introduction to Non-conventional Machining Processes

- **Prerequisite:** Concepts of basic mechanical engineering, Machine tool processes
- **Objectives:**

1. To introduce student about fundamentals of Non-conventional machining processes.
2. To classify the different types of Non-conventional machining processes.
3. To compare between conventional and Non-conventional machining processes.

- **Outcomes:** After completion of this unit, students will be able to -

1. Describe fundamentals of Non-conventional machining processes.

2. Classify different types of Non-conventional machining processes.
3. Compare conventional and Non-conventional machining processes.

• **Unit Content:** Introduction to Non-conventional machining, Need for Non-conventional machining process, Comparison between conventional and Non-conventional machining, classification based on nature of energy employed in machining, advantages, limitations and applications of Non-conventional machining processes.

• **Content Delivery Methods:** Although self-learning course, some interactive sessions shall be conducted with power point Presentation, self-learning tutorials and models.

• **Assessment Methods:** Descriptive questions based upon Non-conventional machining, classification and advantages, limitations and applications of Non-conventional machining.

Unit 2-Overview of Ultrasonic, Water and Abrasive jet Machining

• **Prerequisite:** Non-conventional Processes fundamentals

• **Objectives:**

1. To understand the ultrasonic, water and abrasive jet machining process.
2. To recognize the applications for ultrasonic machining, water and abrasive jet machining.

• **Outcomes:** After completion of this unit, students will be able to -

1. Describe the ultrasonic machining.
2. Identify the use of water and abrasive jet machining.

• **Unit Content:**

Ultrasonic Machining (USM): Introduction, Operating principles, Process parameters, Applications Advantages and Limitations.

Abrasive Jet Machining (AJM): Introduction, Operating principles, Applications Advantages and Limitations.

Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.

• **Content Delivery Methods:** Although self-learning course, some interactive sessions shall be conducted with power point Presentation, self-learning tutorials and models.

• **Assessment Methods:** Descriptive questions based upon ultrasonic machining, water and abrasive jet machining.

Unit 3– Chemical and Electrochemical Machining

Prerequisite: Non-conventional Processes fundamentals.

• **Objectives:**

1To understand the chemical and electrochemical machining process.
2. To recognize the applications for chemical and electrochemical machining process.

• **Outcomes:** After completion of this unit, students will be able to -

1. Describe the chemical and electrochemical machining process machining.
2. Identify the use of chemical and electrochemical machining process.

• **Unit Content:**

Chemical Machining (CHM) -Introduction, Operating principles, Process parameters, Etchants, advantages, limitations and applications of chemical machining process.

Electrochemical Machining (ECM) -Introduction, Operating principles, Process parameters, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

• **Content Delivery Methods:** Although self-learning course, some interactive sessions shall be conducted with power point Presentation, self-learning tutorials and models.

• **Assessment Methods:** Descriptive questions based upon chemical and electrochemical machining process machining.

Section II

Unit 4 -Electrical Discharge Machining (EDM) and Wire Cut Electrical Discharge Machining (WCEDM)

• **Prerequisite:** Non-conventional Processes fundamentals.

• **Objectives:**

1. To understand the Electrical Discharge Machining and Wire Cut Electrical Discharge Machining process.
2. To recognize the applications for Electrical Discharge Machining and Wire Cut Electrical Discharge Machining process.

• **Outcomes:** After completion of this unit, students will be able to -

1. Describe the Electrical Discharge Machining process.
2. Identify the use of Electrical Discharge Machining and Wire Cut Electrical Discharge Machining process.

• **Unit Content:**

Electrical Discharge Machining (EDM) Introduction, mechanism of metal removal,spark erosion generator, dielectric medium-its functions & desirable properties, Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing, Advantages, limitations & applications of EDM.

Wire Cut Electrical Discharge Machining (WCEDM) Operating principles, Applications, Advantages and limitations.

• **Content Delivery Methods:** Although self-learning course, some interactive sessions shall be conducted with power point Presentation, self-learning tutorials and models.

• **Assessment Methods:** Descriptive questions based upon Electrical Discharge Machining and Wire Cut Electrical Discharge Machining process.

Unit 5 – Plasma Arc Machining (PAM) and LASER Beam Machining (LBM)

• **Prerequisite:** Non-conventional Processes fundamentals.

• **Objectives:**

1. To understand the Plasma Arc and LASER Beam Machining process.
2. To recognize the applications for Plasma Arc and LASER Beam Machining process.

• **Outcomes:** After completion of this unit, students will be able to -

1. Describe the Electrical Discharge Plasma Arc and LASER Beam Machining process.
2. Identify the use of Plasma Arc and LASER Beam Machining process.

• **Unit Content:**

Plasma Arc Machining (PAM)-Introduction, non-thermal generation of plasma, process characteristics, applications, advantages and limitations.
LASER Beam Machining (LBM)- Introduction, generation of LASER, Applications, Advantages & limitations.
• **Content Delivery Methods:** Although self-learning course, some interactive sessions shall be conducted with power point, Presentation, self-learning tutorials and models.
• **Assessment Methods:** Descriptive questions based on Plasma Arc and LASER Beam Machining process.

Unit 6 – Electron Beam Machining (EBM) and Iron Beam Machining (IBM)

• **Prerequisite:** Non-conventional Processes fundamentals.
• **Objectives:**
1. To understand the Plasma Arc and LASER Beam Machining process.
2. To recognize the applications for Plasma Arc and LASER Beam Machining process.
• **Outcomes:** After completion of this unit, students will be able to -

1. Describe the Electrical Discharge Plasma Arc and LASER Beam Machining process.
2. Identify the use of Plasma Arc and LASER Beam Machining process.
• **Unit Content:**

Electron Beam Machining (EBM)-Introduction, Operating Principle, applications, advantages and limitations.
Iron Beam Machining (IBM)- Introduction, Operating Principle, applications, advantages and limitations.
• **Content Delivery Methods:** Although self-learning course, some interactive sessions shall be conducted with power point**,** Presentation, self-learning tutorials and models.
• **Assessment Methods:** Descriptive questions based on Plasma Arc and LASER Beam Machining process.

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- Sharma, P. C., *A Text book of Production Engineering,* New Delhi, 1995
- Pandey and Sha, *Modern Manufacturing Process,* Prentice Hall, New Jersey.