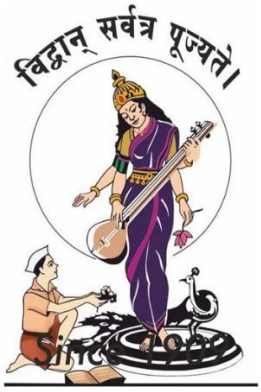


PUNE VIDYARTHI GRIHA'S

COLLEGE OF ENGINEERING AND TECHNOLOGY, PUNE-9

(AFFILIATED TO SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE)

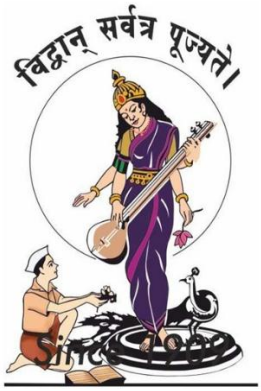
DEPARTMENT OF MECHANICAL ENGINEERING

CURRICULUM BOOK

ACADEMIC YEAR: 2019-20

FOR THE PROGRAMME

MECHANIAL ENGINEERING (UNDER GRADUATE)



PUNE VIDYARTHI GRIHA'S

COLLEGE OF ENGINEERING AND TECHNOLOGY

VISION

TO ACHIEVE EXCELLENCE IN ENGINEERING EDUCATION

MISSION

- **To satisfy all stakeholders**
- **To develop ethical, highly motivated engineering professionals with good human values, requisite skills and competencies**
- **To adopt innovative teaching mechanisms**
- **To promote research culture**
- **To contribute to country's economic development**
- **To be responsive to changes in technology, socio-economic and environmental conditions**

Vision of the Department

"To become premier source of competent Mechanical Engineering professional for providing service to the society"

Mission of the Department

- To provide state of the art facility and to offer opportunities for multifaceted development and enriching learning experience for students, faculty and staff
- To enhance the status as a recognized academic and research Centre in collaboration with other institutions and industry
- To provide interactive and innovative teaching to transform students into competent engineering professionals having good ethical, social and human values
- To deliver ready to employ engineering graduates who are adaptable and practicing lifelong learning to meet the ever changing requirements of the employers

The Program Educational Objectives

- **PEO-I:** To demonstrate the ability to design, develop products, systems and processes in multi-disciplinary engineering environment by application of principles of Science and Engineering
- **PEO-II:** To develop experimental and computational skills necessary to formulate and solve industrial problems related to Mechanical Engineering
- **PEO-III:** To offer sustainable solutions through research, technological competency, leadership skills and team work
- **PEO-IV:** To continue professional development through higher education and lifelong learning
- **PEO-V:** To demonstrate socio-economic, ethical and environmental awareness while making professional decisions

Program Outcomes (POs)

Mechanical 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**: Use 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 team work**: 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.

Program Specific Outcomes (PSOs)

1. **Demonstrate competency in the area of Thermal, Design, Manufacturing and to apply skills in multidisciplinary areas of engineering.**
2. **Face competitive examinations that offer challenging and rewarding careers (pursuing higher studies, general administration or entrepreneurship) in mechanical engineering or other areas.**

INDEX

Third Year

Curriculum Book

Syllabus Structure of SavitribaiPhule Pune University, Pune

T. E. (Mechanical) 2015 course Semester – I

(w.e.f. Academic year 2019-120)

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
302041	Design of Machine Elements – I	4	--	2	30	70	50	--	--	**150**
302042	Heat Transfer	4	--	2	30	70	--	50	--	**150**
302043	Theory of Machines-II	3	1	--	30	70	25	--	25	**150**
302044	Turbo Machines	3	--	2	30	70	--	--	25	**125**
302045	Metrology and Quality Control	3	--	2	30	70	--	--	25	**125**
302046	Skill Development	--	--	2	--	--	25	25	--	**50**
Total of Semester – I		**17**	**1**	**10**	**150**	**350**	**100**	**75**	**75**	**750**

T. E. (Mechanical) Semester – II

Code	Subject	Teaching Scheme (Weekly Load in hrs)			Examination Scheme (Marks)					
		Lect.	Tut	Pract.	Theory		TW	PR	OR	Total
					In Sem.	End Sem.				
302047	Numerical Methods and Optimization	4	--	2	30	70	--	50	--	**150**
302048	Design of Machine Elements -II	4	--	2	30	70	25	--	25	**175**
302049	Refrigeration and Air-conditioning	3	--	2	30	70	--		25	**125**
302050	Mechatronics	3	1	--	30	70	--	--	25	**125**
302051	Manufacturing Process-II	3	--	--	30	70	--	--	--	**100**
302052	Machine Shop -II	--	--	2	--	--	50	--	--	**25**
302053	Seminar	--	--	2			25	--	25	**50**
302054	Audit courses	--	--	--	--	--	--	--	--	--
Total of Semester – II		**17**	1	**10**	**150**	**350**	**100**	**50**	**100**	**750**

TE (Mech)

Semester I

Design of Machine Elements- I

Course Title: Design of Machine Elements I		**Course Number: 302041**	**Course Code: C301**
Year: TE (Mech) 2019-20		**Semester: I**	
Designation of Course		Professional Core/~~Elective~~	
Teaching Scheme		**Theory :** 4 Hrs/Week	**Practical:** 2 Hrs/Week
Course Assessment Methods	**External**	In-semester Examination: 30 Marks	End Semester Examination: 70 Marks
		Term Work 50 marks	
	Internal	Assignments	Class test
Prerequisites	Engineering Mechanics, Strength of Materials		
Course Objectives			
1	To develop the understanding of different steps involved in designing various machine components with reference to stresses involved, material selection and manufacturing methods, type of loads- Static and/or fluctuating		
2	To identify various modes of failure of commonly used machine components and to adopt related design procedure thereafter.		
3	To apply codes and standards to machine component design.		
4	To design and analyze suitable joints, fasteners, screws, welds etc.		
Course Outcomes: At the end of course, students will be able to-			
CO1	Students will be able to **identify** the failure modes for simple mechanical elements depending on the loading using basic knowledge of strength of materials.		
CO2	Students will be able to **solve** the design problems of Shafts, Keys and Coupling.		
CO3	Students will be able to **extend** the design process from static to fluctuating load.		
CO4	Students will be able to **estimate** the suitable dimension of Power Screws for various applications.		
CO5	Students will be able to **choose** the suitable welded and bolted joint for the connection.		
CO6	Students will be able to **decide** on the requirement of spring parameters for the application.		
Course Contents			
Unit-I	**Design of Simple Machine Elements**		
	Machine Design, Design cycle, Design considerations - Strength, Rigidity, Manufacture, Assembly and Cost, Standards and codes, Use of preferred series, Factor of safety, Service factor. Design of Cotter joint, Knuckle joint, Levers - hand / foot lever, lever for safety valve, bell crank lever, and components subjected to eccentric loading.		
Unit-II	**Design of Shafts, Keys and Couplings**		

	Shaft design on the basis of strength, torsional rigidity and lateral rigidity, A.S.M.E. code for shaft design. Transmission shaft:- Theoretical treatment only. Design of keys and splines. Design of Flange Coupling and Flexible Bushed Pin Coupling.
Unit-III	**Design for Fluctuating Load**
	Stress concentration - causes & remedies, fluctuating stresses, fatigue failures, S-N curve, endurance limit, notch sensitivity, endurance strength modifying factors, design for finite and infinite life, cumulative damage in fatigue failure, Soderberg, Gerber, Goodman, Modified Goodman diagrams, Fatigue design of components under combined stresses:- Theoretical treatment only.
Unit-IV	**Power Screws**
	Forms of threads, multiple start screws, Torque analysis and Design of power screws with square and trapezoidal threads, Self locking screw, Collar friction torque, Stresses in power screws, design of a C-Clamp. Design of screw jack, Differential and Compound Screw and Re-circulating Ball Screw (Theoretical treatment only).
Unit- V	**Threaded joints and Welded joints**
	Basic types of screw fasteners, Bolts of uniform strength, I.S.O. Metric screw threads, Bolts under tension, eccentrically loaded bolted joint in shear, Eccentric load perpendicular and parallel to axis of bolt, Eccentric load on circular base, design of Turn Buckle. Welding symbols, Stresses in butt and fillet welds, Strength of butt, parallel and transverse fillet welds, Axially loaded unsymmetrical welded joints, Eccentric load in plane of welds, Welded joints subjected to bending and torsional moments.
Unit-VI	**Mechanical Springs**
	Types, applications and materials for springs, Stress and deflection equations for helical compression Springs, Style of ends, Design of helical compression and tension springs, Springs in series and parallel, Concentric helical springs, Surge in springs, Design of Multi-leaf springs. Helical torsion Spring (Theoretical treatment only).
	Practical/Tutorial/TW
	Term-Work: Term work shall consist of- 1. Two design projects on Assemblies covering above syllabus. The design project shall consist of half imperial sheets (A2 size) involving assembly drawing with a bill of material and overall dimensions and drawings of individual components. The Project should be assigned to a group of three to five students. Project 1 shall be based on any one of the following topics i) Cotter joint/ knuckle joint/turn buckle for a specified application. ii) Transmission Shaft/Machine tool spindles/coupling for specified application. iii) Hand or foot operated levers/lever for safety valve.

	Project 2 shall be based on any one of the following topics i) Bench vice/Machine vice for specified applications. ii) Bottle type/toggle jack for vehicles iii) Lead screw for machine tool/other applications. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified for important surfaces. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. Design data book shall be used wherever necessary for selection of standard components. Drawings of design project should be done manually.. 2. **Assignments** The assignment shall be internally presented in the form of power point presentation, by a group of three to five students. A report of assignment (Max 8 to 10 pages) along with print out of ppt is to be submitted. Each student shall complete any two of the following assignments, with Assignment (a) compulsory. a) Use of dimensional tolerances, Geometrical tolerances and surface finish symbols in machine component drawings. b) Selection of materials using weighted point method. c) Selection of manufacturing methods for machine elements designed in any one of the above design projects. d) Theories of failures and their applications.

Text Books	**Author**	**Title of Book**	**Publication**
T1	Shigley J.E. and Mischke C.R.	Mechanical Engineering Design	McGraw Hill Publication Co. Ltd.
T2	Spotts M.F. and Shoup .E.	Design of Machine Elements	Prentice Hall International.
T3	Bhandari V.B.	Design of Machine Elements,	Tata McGraw Hill Publication Co. Ltd.
T4	Juvinal R.C.	Fundamentals of Machine Components Design	John Wiley and Sons
Reference Books			
R1	Black P.H. and O. Eugene Adams	Machine Design	McGraw Hill
R2	Willium C. Orthwein	Machine Components Design	West Publishing Co. and Jaico Publications
R3	Hall A.S.	Theory and Problems of Machine Design,	Schaum's Outline Series.
R4	C.S.Sharma and Kamlesh Purohit	Design of Machine Elements	PHI Learing Pvt. Ltd
R5	P.S.G. College of Technology, Coimbatore.	Design data book	P.S.G. College of Technology, Coimbatore.

Self-Learning Facilities, Web Resources, Research papers for reference	NPTEL Video Lectures
Contents beyond Syllabus	Stress Analysis using ANSYS
Additional Experiments	NIL
Bridging Courses	NIL
Tutorials	NIL
Presentations	NPTEL Videos will be shared to students

Heat Transfer

Course Title: Heat Transfer		**Course Number**	**Course Code: : 302042**
Year: TE Mechanical		**Semester: I**	
Designation of Course		Professional Core	
Teaching Scheme: 4 Hrs/Week		**Practical:** 2 Hrs/Week	
Course Assessment Methods	**Direct External Methods**	In-semester Examination: 30 Marks	End Semester Examination: 70 Marks
		Practical Examination: 50 Marks	
	Direct Internal Methods	Class Tests	Assignments
Prerequisites	Engineering Mathematics, Engineering Physics, Basics of Thermodynamics, Fluid Mechanics		
Course Objectives			
1	To identify and understand the important modes of heat transfer and their applications. To understand laws and different terms associated with heat transfer and to derive heat conduction equation in different forms. To introduce students to steady state heat conduction with different standard geometries		
2	To formulate and apply the general three dimensional heat conduction equations. To introduce students to steady state heat conduction with heat generation. Analyse the thermal systems with internal heat generation and lumped heat capacitance and to understand transient heat conduction with and without variation of temperature with space		
3	To understand different boundary and initial conditions used in heat transfer analysis and to introduce the concept of fins and the analysis of heat transfer using fins		
4	To understand the principles and mechanism of convective heat transfer. To analyse the convective heat transfer problems.		
5	To determine the radiative heat transfer between surfaces. To understand thermal radiation, terms, laws and problems associated with it.		
6	Describe the various two phase heat transfer phenomenon. Execute the effectiveness and rating of heat exchangers.		
Course Outcomes			
C302042.1	Students will be able to i**dentify** the various modes of heat transfer and **implement** the basic heat conduction equations for steady one dimensional thermal system without internal heat generation.		
C302042.2	Students will be able to **analyse** the thermal systems with internal heat		

	generation and heat transfer by extended surfaces.
C302042.3	Students will be able to **understand** the concept of thermal insulation and will be able to **analyse** the thermal systems with lumped heat capacitance
C302042.4	Students will be able to **analyse** the heat transfer rate in natural and forced convection and **evaluate** through experimentation investigation.
C302042.5	Students will be able to **interpret** heat transfer by radiation between objects with simple geometries
C302042.6	Students will be able to **describe** the various two phase heat transfer phenomenon and **execute** the effectiveness and rating of heat exchangers
Course Contents	
Unit-I **Conduction**	***Introduction and Basic Concepts***
	Application areas of heat transfer, Modes and Laws of heat transfer, Three dimensional heat conduction equation in Cartesian coordinates and its simplified equations, thermal conductivity, Thermal diffusivity, Thermal contact Resistance
	Boundary and initial conditions
	Temperature boundary condition, heat flux boundary condition, convection boundary condition, radiation boundary condition.
	One dimensional steady state heat conduction without heat generation
	Heat conduction in plane wall, composite slab, composite cylinder, composite sphere, electrical analogy, concept of thermal resistance and conductance, three dimensional heat conduction equations in cylindrical and spherical coordinates (no derivation) and its reduction to one dimensional form, critical radius of insulation for cylinders and spheres, economic thickness of insulation.
	Practical/Assignment
	1. Determination of Thermal Conductivity of Insulating Powder. 2. Determination of Thermal Conductivity of Composite Slab 3. Determination of Thermal Conductivity of Metal Rod
Unit-II **Heat Conduction with Internal Heat Generation & Heat Transfer Through Extended Surfaces**	***One dimensional steady state heat conduction with heat generation***
	Heat conduction with uniform heat generation in plane wall, cylinder & sphere with different boundary conditions.
	Heat transfer through extended surface
	Types of fins and its applications, Governing Equation for constant cross sectional area fins, solution for infinitely long & adequately long (with insulated end) fins, efficiency & effectiveness of fins.
	Practical/Assignment

	Determination of temperature distribution, fin efficiency in Natural / Forced Convection
Unit-III **Thermal Insulation & Transient Heat Conduction**	***Thermal Insulation***
	Types and selection, Economic and cost considerations, Payback period
	Transient heat conduction
	Validity and criteria of lumped system analysis, Biot and Fourier number, Time constant and response of thermocouple, Transient heat analysis using charts.
	Practical/Assignment
	Assignment to solve transient heat transfer problem using Heisler and Grober charts.
Unit-IV **Convection**	***Fundamentals of Convection***
	Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity & thermal boundary layers.
	Forced Convection
	Dimensionless numbers and their physical significance, empirical correlations for external & internal flow for both laminar and turbulent flows.
	Natural Convection
	Introduction, dimensionless numbers and their physical significance, empirical correlations for natural convection.
	Practical/Assignment
	1. Determination of heat transfer coefficient in Natural Convection 2. Determination of heat transfer coefficient in Forced Convection
Unit-V **Thermal Radiation**	***Thermal Radiation***
	Fundamental concepts, Spectral and total emissive power, real and grey surfaces, Stefan Boltzmann law, Radiation laws – Planks, Wiens, Kirchoff's and Lambart's cosine law with simple applications, Irradiation and radiosity, Electrical analogy in radiation, Radiation shape factor, radiation heat exchange between two black and diffuse gray surfaces, radiation shield.
	Practical/Assignment
	1. Determination of Emissivity of a Test surface 2. Determination of Stefan Boltzmann Constant
Unit-VI **Heat Transfer Equipments**	***Condensation and Boiling***
	Boiling heat transfer, types of boiling, pool boiling curve and forced boiling phenomenon, condensation heat transfer, film wise and drop wise condensation (simple numerical treatment).
	Heat Exchangers

	Classification and applications, heat exchanger analysis – LMTD for parallel and counter flow heat exchanger, effectiveness– NTU method for parallel and counter flow heat exchanger, cross flow heat exchanger, LMTD correction factor, design criteria for heat exchanger, Introduction to TEMA standards. Introduction to heat pipe, Introduction to electronic cooling - Discussion on active and passive methods		
	Practical/Assignment		
	1. Assignment on multi-pass/cross heat exchanger using effectiveness charts. 2. Study of pool boiling phenomenon and determination of critical heat flux		
Text Books	**Author**	**Title of Book**	**Publication**
T1	R. K. Rajput	Heat and Mass Transfer	S. Chand Publications
T2	P K Nag	Heat and Mass Transfer	McGraw Hill Publication
T3	S.P. Sukhatme	A Textbook on Heat Transfer	Universities Press
Reference Books			
R1	J P Holman	Fundamentals of Heat and Mass Transfer	McGraw Hill Publication
R2	F.P. Incropera, D.P. Dewitt	Fundamentals of Heat and Mass Transfer	John Wiley
R3	Y.A. Cengel	Heat Transfer a Practical Approach	McGraw Hill Education Private Limited.
Self-Learning Facilities, **Web Resources,** **Research papers for reference**	NPTEL Video lectures		
Contents beyond Syllabus	None		
Additional Experiments	Heat pipe experiment		
Bridging Courses	None		
Tutorials	None		
Presentations	None		

Theory of Machines-II

Course Title: Theory of Machine II		**Course Number: 302043**	**Course Code:C303**
Year: TE		**Semester: I**	
Designation of Course		Core	
Teaching Scheme: 3 Hrs/Week		**Tutorial:** 1 Hr/Week	
Course Assessment Methods	**External Tools**	In-semester Examination: 30 Marks	End Semester Examination: 70 Marks
		Class Test: 30 Marks	Oral: 25 Term Work: 25
	Internal Tools	Class Test	Assignments
Prerequisites	Engineering Mechanics, Physics, Strength of Material		
Course Objectives			
1	To develop competency in understanding of theory of all gears		
2	To understand the analysis of gear train		
3	To develop competency in drawing the cam profile		
4	To make the student conversant with synthesis of the mechanism		
5	To understand the step less regulations		
6	To understand mechanisms for system control-Gyroscope		
Course Outcomes			
CO1	Student will be able to **apply** fundamentals of gear theory for gear design		
CO2	Student will be able to **perform** force analysis of Spur, Helical, Bevel, Worm and Worm Gear		
CO3	Student will be able to **analyze** speed and torque in epi-cyclic gear trains which will be the pre requisite for gear box design		
CO4	Student will be able to **design** cam profile for given follower motions and understand cam jump phenomenon, advance cam curves		
CO5	Student will be able to **synthesize** a four bar mechanism with analytical and graphical methods		
CO6	a. Student will be able to **analyze** the gyroscopic couple or effect for stabilization of Ship, Aeroplane and Four wheeler vehicle b. Student will be able to **choose** appropriate drive for given application (stepped/step-less)		
Course Contents			
Unit-I	**Spur Gear** **(8 Hrs)** Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, interference and under cutting – Methods to avoid interference. Minimum number of teeth on gear and pinion only, Force analysis and Friction in gears.		
Unit-II	**Helical, Bevel, Worm and Worm Wheel** **(6 Hrs)** Helical and Spiral Gears: terminology, geometrical relationships, tooth forces, torque transmitted and efficiency, virtual number of teeth for helical gears		

	Bevel Gear & Worm and worm wheel: terminology, geometrical relationships, tooth forces, torque transmitted.Bevel Gear: Theoretical treatment only.
Unit-III	**Gear Trains (6 Hrs)** Types of Gear Trains, analysis of epicyclic gear trains, Holding torque – Simple, compound and epicyclic gear trains, torque on sun and planetary gear train, compound epicyclic gear train, Bevel epicyclic Gear train.
Unit-IV	**Cam and Follower (8 Hrs)** Types of cams and followers, analysis of standard motions to the follower, Determination of cam profiles for different follower motions, Methods of control: pressure angle, radius of curvature and undercutting. Jump phenomenon of Eccentric cam, Introduction to advanced cam curves (up to 3-4-5 Polynomial cam only)
Unit- V	**Synthesis of Mechanism (8 Hrs)** Steps in synthesis process: Type, number and dimensional synthesis. Tasks of Kinematic synthesis: Path, function and motion generation (Body guidance). Precision Positions, Chebychev spacing, Mechanical and structural errors. Three position synthesis of four bar mechanism using Freudenstein's equation. Analytical synthesis using kinematic coefficient in four bar mechanism.
Unit-VI	**Step–Less-Regulation** (Theoretical Treatment only) **&Gyroscope (6 Hrs)** Continuous Variable Transmissions - Geometry, Velocity and torque analysis of Faceplate variators, conical variators, Spheroidal and cone variators, Variators with axially displaceable cones, PIV drives. Gyroscopes, Gyroscopic forces and Couples, Gyroscopic stabilisation for ship and Aeroplane, Stability of four wheel vehicle moving on curved path.
List of Tutorial	• To study manufacturing of gear using gear generation with rack as a cutter and to generate involute profile. • To draw conjugate profile for any general type of gear tooth. (Half imperial drawing sheet) • Speed and torque analysis of epicyclic gear train to determine holding torque. • Kinematic analysis of synchromesh, machine tool gear box, differential gear box. • To draw the cam profile and study variation in pressure angle with respect to change in base circle diameter and draw pitch circle for both

	the cases.(Half imperial drawing sheet) • To verify the cam jump phenomenon for eccentric cam. • To synthesize the four bar and slider crank mechanism using relative pole and inversion method with three accuracy points. (Half imperial drawing sheet) • Study of Continuous Variable Transmission and Infinite Variable Transmission. • To determine the effect of active gyroscopic couple on a spinning disc and verify the gyroscopic effect.

Text Books	**Author**	**Title of Book**	**Publication**
T1	S. S. Rattan	Theory of Machines	McGraw Hill Education
T2	Thomas Bevan	Theory of Machines	Longman
T3	A.G. Ambekar	Mechanism and Machine Theory	PHI
T4	N. K. Mehta	Machine Tool Design	Tata McGraw Hill
T5	J.J.Uicker, G.R.Pennock, J.E.Shigley	Theory of Machines and Mechanisms	OXFORD
Reference Books			
R1	Ghosh Malik	Theory of Mechanism and Machines	East West
R2	Hannah and Stephans	Mechanics of Machines	Edward Arnolde Publication
R3	R L Norton	Kinematics and Dynamics of Machinery	McGraw Hill Education
R4	Sadhu Singh	Theory of Machines	Pearson
R5	D.K. Pal, S.K. Basu,	Design of Machine Tools,	Oxford &Ibh Publishing Co Pvt. Ltd.
Self-Learning Facilities, Web Resources, Research papers for reference	Animations, NPTEL Video		
Contents beyond Syllabus			
Additional Experiments			
Bridging Courses			
Presentations			

Turbo Machines

Course Title: Turbo Machines		**Course Number:**	**Course Code: 302044**
Year: TE		**Semester: I**	
Designation of Course		Professional Core	
Teaching Scheme: 4 Hrs/Week		**Practical:** -- 2 Hrs/Week	
Course Assessment Methods	**Direct methods**	In-semester Examination: 30 Marks	End Semester Examination: 70 Marks
		Oral Exam: 25 marks	
	Indirect Methods	Class Test	Assignments
Prerequisites	Concepts of compressible and incompressible fluid flow, Basics of applied thermodynamics, Fluid Mechanics, concept of mass and energy conservation, velocity, acceleration, force and energy, Integral calculus and Differential equations. Newton's laws of motion.		
Course Objectives			
1	Provide students with opportunities to apply basic flow equations like mass conservation, energy conservation equations.		
2	Train the students to acquire the knowledge and skill of analyzing different turbo machines.		
3	How to compare and chose machines for various operations		
Course Outcomes			
CO1	Apply impulse momentum principle to the impact of jet on stationary, moving and series of vanes		
CO2	Understand and analyze the performance of Impulse turbines		
CO3	Understand and analyze performance of Reaction turbines		
CO4	Study steam nozzles and analyze performance of Steam turbines		
CO5	Understand and analyze performance of centrifugal pumps		
CO6	Understand and analyze performance of Centrifugal Compressors and Axial flow compressors		
Course Contents			
Unit-I	**Introduction to Turbo Machinery** Turbo machines (Hydraulic & Thermal), Classification of Turbo machines, Comparison with positive displacement machines, Fundamental equation governing turbo machines and Different losses associated with turbo-machinery, Applications of Turbo machines. **Impact of Jet** Impulse momentum principle and its applications, Force exerted on fixed and moving flat plate, hinged plate, curved vanes, series of flat plates and radial vanes, velocity triangles and their analysis, work done equations, vane efficiency.		
	Practical/Tutorial		
	1. Verification of impulse momentum principle		
Unit-II	**Impulse Water Turbines**		

	Introduction to Hydro power plant, classification of hydraulic turbines construction, principle of working, velocity diagrams and analysis, design aspects, performance parameters, performance characteristics, specific speed, selection of turbines, multi-jet Pelton wheel.
	Practical/Tutorial
	1. Study and trial on impulse water turbine (Pelton wheel) and plotting of main and operating characteristics
Unit-III	**Reaction Water Turbines**
	Classifications, Francis, Propeller, Kaplan Turbines, construction features, velocity diagrams and analysis, degree of reaction, performance characteristics. Draft tubes: types and analysis, causes and remedies for cavitation phenomenon. Governing of turbines, Similitude and dimensional analysis of hydraulic turbines
	Practical/Tutorial
	1. Study and trial on any one hydraulic reaction turbine (Francis/Kaplan) and plotting of main and operating characteristics
Unit- IV	**Steam Turbines**
	Steam nozzles: types and applications, Equation for velocity and mass flow rate [No numerical treatment]. **Steam Turbines:** Classifications, construction details, compounding of steam turbines, velocity diagrams and analysis of Impulse and reaction turbines (single & multi stage), governing, dimensional analysis, performance characteristics. Losses in steam turbines, selection of turbines.
	Practical/Tutorial
	1. Study of different types of nozzles and trial on convergent-divergent air/steam nozzle. 2. Visit to hydro/steam power plant and report to be submitted 3. Study of multi-staging of steam turbines
Unit-V	**Centrifugal Pumps**
	Classification of rotodynamic pumps, components of centrifugal pump, types of heads, velocity triangles and their analysis, effect of outlet blade angle, cavitation, NPSH, Thoma's cavitation factor, priming of pumps, installation, specific speed, performance characteristics of centrifugal pump, series and parallel operation of pumps, system resistance curve, selection of pumps. Dimensional and Model analysis of hydraulic machines
	Practical/Tutorial
	1. Study and trial on centrifugal pump and plotting operating characteristics 2. Design of pumping system installation using manufacturers' catalogue, specific to housing or industrial application.

	3. Visit to pumping station and report to be submitted.		
Unit-VI	**Centrifugal and Axial Compressor**		
	Centrifugal compressor: Classification of compressors, Construction, velocity diagram, flow process on T-S Diagram, Euler's work, actual work input, performance characteristics, various losses in centrifugal compressor. **Axial Compressor:** Construction, stage velocity triangles and its analysis, enthalpy entropy diagram, stage losses and efficiencies, performance characteristics. [No numerical treatment]		
	Practical/Tutorial		
	1. Study and trial on centrifugal air compressor and plotting its characteristics 2. Study of axial flow compressors/ centrifugal air blower		
Text Books	**Author**	**Title of Book**	**Publication**
T1	Dr. R.K. Bansal	Fluid Mechanics and Hydraulic Machines	Lakshmi Publications Pvt. Ltd.
T2	R. K. Rajput	Fluid Mechanics and Hydraulic Machines	S. Chand Publications
T3	Dr. R. Yadav	Steam & Gas Turbines and Power plant Engineering	Central Publishing House Allahabad
Reference Books			
R1	V.P. Vasandani	Theory of Hydraulic Machinary	Khanna Publishers, Delhi
R2	Modi P N & Seth S N	Hydraulics, Fluid Mechanics and Machinery	Standard Book House ,New Delhi.
R3	S.M. Yahya	Turbines, Compressors & Fans,	Tata-McGraw Hill
Self-Learning Facilities, Web Resources, Research papers for reference	NPTEL Lectures and Lecture notes		
Contents beyond Syllabus	None		
Additional Experiments	None		
Bridging Courses	None		
Tutorials	None		
Presentations	None		

METROLOGY & QUALITY CONTROL

Course Title: METROLOGY & QUALITY CONTROL		**Course Number: C 305**	**Course Code:302045**
Year: 2018-19		**Semester: II**	
Designation of Course		Professional Core	
Teaching Scheme: 03 Hrs/Week(Theory)		**Tutorial:** 1 Hr/Week	
Course Assessment Methods	**Direct Method**	In-semester 30 Marks	End Semester Examination 70 Marks
		Oral (25 Marks)	
	Indirect Method	Class Test	Assignments
Prerequisites	Knowledge of PHYSICS, BASIC MATHEMATICS., manufacturing processes, Workshop Practices		
Course Objectives			
1	Select suitable instrument / gauge / method of inspection for determining geometrical and dimensional measurements.		
2	Calibrate measuring instruments and also design inspection gauges.		
3	Understand the advances in Metrology such as use of CMM, Laser, Machine Vision System for Metrology etc.		
4	Select and apply appropriate Quality Control Technique for given application.		
5	Select and Apply appropriate Quality Management Tool and suggest appropriate Quality Management System (QMS).		
Course Outcomes			
CO1	Calibrate measuring instruments and also design inspection gauges.		
CO2	An ability to perform experiments, as well as to analyse and interpret data		
CO3	An ability to design gauges to meet desired needs within realistic constraints		
CO4	An understanding of quality control techniques and its applications in engineering industries		
CO5	Ability to practice various methods of quality management		
CO6	To measure the statistically the beahaviour of the process by control charts.		

Course Contents	
Unit-I	**Measurement standards and Design of gauges**
	Introduction: Principles of Engineering metrology, Measurement standards, Types and sources of errors, Accuracy and Precision, Calibration: Concept and procedure, traceability, Geometric Form Measurement: Straightness, Flatness, Roundness - Straight edge, use of level beam comparator, autocollimator testing of flatness of surface plate. Design of Gauges: Tolerances, Limits and Fits [IS 919-1993], Taylor's principle, Types of gauges, Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Considerations of gauge design (numerical).
	Assignment
	• Assignment on types and sources of errors in measurement & concept of Precision & accuracy. • Design of Gauges for Hole & Shaft on Taylor's Principle • Assignment on Geometrical Form Measurement
	Practical
	• Demonstration of linear and angular measuring instruments, slip gauges and their applications. • Error determination of linear / angular measuring instruments and determination of linear and angular dimensions of given part, (MSA: Gauge R & R). • 3Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one) (Refer ISO 17025).
Unit-II	**Comparators, Thread and Gear Metrology, Surface Roughness Measurement**
	• Comparators: Mechanical, Pneumatic, Optical, Electrical (LVDT). • Measurement of Thread form: Thread form errors, Measurement of Minor, Major and Effective diameter (Three Wire Method), Flank angle and Pitch, Floating Carriage Micrometer (Numerical). • Gear Metrology: Errors in Spur Gear form, Gear tooth Vernier, Constant chord, Base tangent (Numerical), Gear Rolling Tester. Profile Projector, Tool maker's microscope and their applications • Surface Roughness Measurement: Introduction to Surface texture, Parameters for measuring surface roughness, Surface roughness measuring instrument: TalySurf.
	Assignment
	• Assignment on types of comparator • Numericals on Screw Thread Measurement • Numerical on gear metrology • Assignment on surface roughness measurements
	Practical
	• Verification of dimensions and geometry of given components using

	Mechanical /Pneumatic comparator. [An assignment with this experiment write-up as, Introduction to use of Standard CODE viz. ASME-Y14.5, ISO-1101]. • Measurement of thread parameters using floating carriage diameter measuring machine. • Measurement of spur gear parameters using Gear Tooth Vernier / Span Micrometer / Gear Rolling Tester.
Unit-III	**Advances in Metrology**
	• Coordinate Measuring Machine (CMM): Fundamental features of CMM – development of CMMs – role of CMMs – types of CMM and Applications, – types of probes • Machine Vision Systems: vision system measurement – Multisensory systems. • Interferometer: Principle, NPL Interferometer • Laser Metrology: Basic concepts of lasers, advantages of lasers, laser interferometers, types, application
	Assignment
	Assignmeent on CMM and LASER metrology
	Practical
	• Determination of given geometry using coordinate measuring machine (CMM). • Demonstration of surfaces inspection using optical flat/interferometers. / Demonstration of surface roughness measurement using surface roughness tester.
Unit-IV	**Introduction to Quality and Quality Tools**
	Concept of Quality: Various Definitions and Quality Statements, Cost of quality & value of quality, Deming's cycles & 14 Points, Juran Trilogy approach, Old New Seven Tools, Quality Circles. **Importance of Quality deployment at Design and Manufacturing Engineering:** Opportunities for improvement product design, Importance of– initial planning for quality, concept of controllability: self-controls – defining quality responsibilities on the factory flow – self inspection.
	Assignment
	1. Analyze the fault in given batch of specimens by using seven quality control tools for engineering application. Submission of these assignments USING STANDAED FORMATS.
Unit- V	**Statistical quality control**

	• **Statistical quality control:** Statistical concept, Frequency diagram, Concept of variance analysis, Control Chart for Variable (X & R Chart) & Attribute (P & C Chart), Process capability(Indices: cp, cpk, ppk), Statistical Process Control (Numerical). Production Part Approval Method (PPAP). • **Acceptance Sampling:** Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plan: Single, Double (Numerical), Multiple, Comparison of Plan, calculation of sample size, AOQ, Probability of Acceptance (Numerical)
	Assignment
	1.Determination of process capability from given components and plot variable control chart/ attribute chart
	Practical
	Determination of process capability from given components and plot variable control chart/ attribute chart.
Unit-VI	**Total Quality Management**
	TQM: Introduction, Quality Function Deployment, 5S, Kaizen, Poka yoke, Kanban, JIT, FMECA, Zero defects, TPM. Six Sigma: DMAIC - Concept and Applications. **Quality Management System** Need for quality management system – design of quality management system - quality management system requirements – ISO 9001, TS-16949, ISO-14000, Quality Audit.
	Assignment
	Assignment on Total Quality Management

Text Books	**Author**	**Title of Book**	**Publication**
T1	Jain R.K.	Engineering Metrology	Khanna Publication
T2	Hume K.J	Engineering Metrology	Macdonald Publications
T3	Juran J. M	Quality Handbook	McGraw Hill Publications
T4	Grant S.P	Statistical Quality Control	Tata McGraw hill Publication
Reference Books			
R1	Hume K.J	Engineering Precision Measurements	Chapman and Hall
R2	Gupta I.C	Engineering Metrology	Dhanpatrai Publications
R3	Harrison M	Stefeen Godfrey, Modern Methods for Quality control and improvement	Willy Publication
R4	ASTME	Handbook of Industrial Metrology	Prentice Hall of India Ltd.

Self-Learning Facilities, Web Resources, Research papers for reference	**Online Education resources: viz. NPTEL web site**: (1) nptel.ac.in/courses/112106179; (2) www.nptelvideos.in/2012/12/mechanical-measurements and metrology html (3) www.me.iitb.ac.in/~ramesh/courses/ME338/metrology6.pdf; nptel.ac.in/courses/110101010/; (4) freevideolectures.com › Mechanical › IIT Madras
Contents beyond Syllabus	Geometric Dimensioning & tolerancing for CMM.
Additional Experiments	--
Bridging Courses	Basic Training Courses For GD & T, Quality Analysis by Minitab
Assignments	Assignment on last 3 unit.
Tutorials	Three Tutorials(Unit 1&2,Unit 3&4,Unit 5&6)
Presentations	CD Presentations, PPT Presentations.