

COURSE TITLE : DESIGN OF MACHINE ELEMENTS
COURSE CODE : 5021
COURSE CATEGORY : A
PERIODS/ WEEK : 5
PERIODS/ SEMESTER : 75
CREDIT : 5

TIME SCHEDULE

MODULE	TOPIC	PERIODS
1	Introduction to Design of machine elements. Design of bolt, nuts and keys. Power screws.	20
2	Shaft and coupling	15
3	Bearing. Cam. Governor and fly wheel	20
4	Belt, rope and chain drive. Gear and gear train.	20
TOTAL		75

COURSE OUTCOME :

sl.no.	sub	student will be able to
1	1	Understand the factors governing the design of machine elements.
	2	Comprehend the design of Nut, Bolt, Keys using empirical and analytical method
	3	Appreciate the working and efficiency of power screws.
2	4	Understand the design of shaft and power transmission
	5	Comprehend the design of coupling by analytical and empirical method.
	6	Understand the basic design procedure for bearings.
3	7	Comprehend the construction of Cam and Follower and purpose of governor and fly wheel.
	8	Understand the application of belt, rope and chain drive.
	9	Appreciate the design of gear proportion and gear train.

SPECIFIC OUTCOME

MODULE I

1.1.0 Understand the factors governing the Design of Machine elements

- 1.1.1 List the factors governing the design
- 1.1.2 Define the general procedure for design
- 1.1.3 Illustrate the methods of design – analytical and empirical
- 1.1.4 Explain design stress, working stress and factor of safety

1.2.0 Design of Bolts, Nuts and Keys using analytical and empirical methods

- 1.2.1 Define the important terms used in screw threads
- 1.2.2 List the standard dimensions of screw threads and empirical formulae
- 1.2.3 Explain the designation of screw threads

- 1.2.4 Identify the stresses due to static loading, initial stresses and stresses due to external forces, stresses due to combined forces
- 1.2.5 Estimate the size of the screw from above stresses
- 1.2.6 Design cylinder covers
- 1.2.7 Simple problems related to design of cylinder covers
- 1.2.8 Explain the bolts of uniform strength
- 1.2.9 Classify the various types of keys
- 1.2.10 Determine the proportions of sunk key
- 1.2.11 Calculate the strength of rectangular sunk key and square sunk key
- 1.2.12 Select the key size using empirical proportions, simple problems
- 1.3.0 Analyze the working efficiency of screw jack**
- 1.3.1 Determine the effort, torque required and efficiency of a square threaded screw jack with collar and without collar friction
- 1.3.2 Calculate the maximum efficiency of a square threaded screw
- 1.3.3 Describe overhauling and self locking
- 1.3.4 Calculate the efficiency of self locking screw jack

MODULE II

2.1.0 Design Shafts and Power Transmitted by Shafts

- 2.1.1 State torsion equation and explain each term
- 2.1.2 Design the diameter of solid and hollow shafts from strength and rigidity considerations
- 2.1.3 Determine the power transmitted by the shafts subjected to torque
- 2.1.4 Calculate the diameter of shaft considering strength and stiffness
- 2.1.5 Compare solid and hollow shafts in terms of their weight, strength and stiffness

2.2.0 Design coupling using analytical and empirical methods and check for safety

- 2.2.1 State the purpose of couplings
- 2.2.2 Design the dimensions of muff coupling
- 2.2.3 Design the dimensions of rigid flange coupling and check for safety 4
- 2.2.4 Draw the above coupling after calculating the dimensions

MODULE III

3.1.0 Justify the basic design procedure of bearings

3.1.1 State the functions of bearings

- 3.1.2 Classify the bearings
- 3.1.3 Explain generally as to what is meant by sliding contact and rolling contact bearings
- 3.1.4 Estimate the proportions of solid journal bearing empirically based on journal diameter and sketch
- 3.1.5 Explain the bearing characteristic number and the significance of bearing modulus
- 3.1.6 Determine the proportions of a foot step bearing empirically based on shaft diameter and sketch
- 3.1.7 Design of journal bearing given the load allowable bearing pressure and l/d ratio
- 3.1.8 Solve simple problems involving the design of solid journal bearings and foot step bearings
- 3.1.9 Calculate the Heat generated in journal bearings

3.2.0 Recognize different types of Cams and Followers

- 3.2.1 Define various terms of cam terminology

- 3.2.2 Explain the various displacement diagrams
- 3.2.3 Draw the cam profiles of a disc cam with offset and without off set for knife edge and roller follower
- 3.3.0 Appreciate the purpose and uses of Governors and Flywheels**
- 3.3.1 Explain the function of governors
- 3.3.2 list the types of governors
- 3.3.3 Illustrate the principle of working of simple watt governor and porter governor
- 3.3.4 Identify the terms used in governors – height of governors, equilibrium speed, mean equilibrium speed, maximum and minimum equilibrium speed, sleeve lift, sensitiveness, stability and hunting of governors
- 3.3.5 Explain the functions of fly wheel
- 3.3.6 Compare the functions of flywheel with governor
- 3.3.7 Explain fluctuation of speed, fluctuation of energy, coefficient of fluctuation speed, coefficient of fluctuation of energy, energy stored in fly wheels, turning moment diagrams

MODULE IV

- 4.1.0 Appreciate the application of Belt, Rope and Chain Drive
- 4.1.1 State the application of belt drives
- 4.1.2 Explain the terms open belt, crossed belt, angle of lap belt, slack and tight sides, velocity ratio, slip, creep, centrifugal tension and power transmitted
- 4.1.3 Solve simple problems related to V.R. and slip
- 4.1.4 Calculate the Length of belt of an open belt and crossed belt (No derivation.)
- 4.1.5 State the Ratio of belt tensions (no proof)
- 4.1.6 Determine the power transmitted by a belt
- 4.1.7 Calculate the width of flat belt without considering centrifugal tension
- 4.1.8 Illustrate V belt, rope or circular belt drive
- 4.1.9 State the advantages and disadvantages of chain drive over belt drive
- 4.2.0 Design Gear proportions and gear trains**
- 4.2.1 State the function of gear and friction wheel
- 4.2.2 Mention the advantages and disadvantages of gear drive
- 4.2.3 Illustrate the spur gear nomenclature including addendum, dedendum, module, pitch circle, circular pitch, pitch point, diametric pitch, clearance
- 4.2.4 Explain simple gear train, compound gear train, reverted gear train and epicyclic gear train
- 4.2.5 **Solve simple problems on simple and compound gear trains**

CONTENT DETAILS

MODULE I

Introduction - General considerations – General procedure - Design stress and working stress - factor of safety – introduction to design data book.

Bolts, Nuts and Key

Designation and nomenclature of screw thread - stresses in screwed fastenings due to static loading - initial stresses -stresses due to external forces – Estimation of screw size - stresses due to combined forces -simple problems - design of cylinder covers - simple problems - bolts of uniform strength –

Types of keys - forces acting on a sunk key - strength of a sunk key – Square and rectangular - calculation of key size using empirical proportions - simple problems.

Screw jack - Torque required to raise and lower the load – square threaded screw jack with collar (without collar friction)- Self-locking screw jack – efficiency and overhauling - simple problems.

MODULE II

Tensional stresses and strains (Review) - strength of solid and hollow shaft - comparisons - problems – power transmitted by shaft – simple problems - working stresses for shafts - design of shaft based on strength and rigidity - shafts subjected to twisting moment and bending moment – simple problems - design of shafts on the basis of torsional rigidity- simple problems -Compare solid and hollow shaft in terms of their weight, strength and stiffness –simple problems.

Couplings

Shaft couplings - requirement - types -design of sleeve or muff coupling - design and sketch flange coupling using calculated values-unprotected type –simple problems.

MODULE III

BEARINGS

Functions - classification of bearings - Radial bearings - thrust bearings - sliding contact bearings - rolling contact bearings - design and sketch solid journal bearing based on journal diameter, bearing pressure and L/D ratio- friction in journal bearing -design of thrust bearing considering uniform pressure - flat pivot or foot step bearing-coefficient of friction and bearing characteristic number - heat generated in journal bearings –Problems from each of the above

Cams

Classification of followers and cams - cam terminology -motion of the followers - uniform velocity, simple harmonic motion - uniform acceleration and retardation - displacement diagrams -construction of cam profile with reciprocating followers - knife edge follower, follower axis passes through the cam axis and offset - roller follower, follower axis passes through the cam axis and offset

Governors and Flywheels

Functions of the governors - types of governors - simple watt governor - porter governor –terms in governors –height of governor ,equilibrium speed, mean equilibrium speed, maximum & minimum equilibrium speed, sleeve fit, sensitiveness, stability and hunting of governors

Flywheels

Functions-comparison with governors – fluctuation of speed, fluctuation of energy, coefficient of fluctuation of speed, coefficient of fluctuation energy-Energy stored in flywheels- Turning moment diagrams.

MODULE IV

BELT, ROPE AND CHAIN DRIVE

Types of belts - flat belt, circular belt or rope, V-belt - types of flat belt drives - open and crossed belt drive - compound belt drive - stepped or cone pulley drive - velocity ratio - slip - creep -problems - length of an open belt - length of crossed belt - problems - power transmitted by a belt -ratio driving tensions for flat belt drive (no proof) - angle of contact - problems - centrifugal tension - calculation of

width of the belt (without considering centrifugal tension) – problems V-belt drive - rope or circular belt drive - chain drive – advantages and disadvantages over belt drive.

Gears and Gear Trains

Functions of gears - friction wheels - advantages and disadvantages of a gear drive - spur gear nomenclature – addendum, dedendum, module, pitch circle, circular pitch, pitch point, diametric pitch, and clearance.

Simple gear drive - Velocity ratio - gear trains - simple gear train - compound gear train - reverted gear train - epicyclic gear train –simple problems on simple and compound gear trains-number of teeth and gears.

TEXT BOOKS

1. A text book of Machine Design - R.S. Khurmi and J.K. Gupta
2. A text book of Theory of Machines - R.S. Khurmi and J.K. Gupta
3. A text book of Strength of Materials - Dr. R.K. Bansal

REFERENCE

1. A Text book of Automobile Engineering - T.R. Banger and Nathu Singh
2. Machine Design - Dr. Sadhu Singh.
3. Design of Machine elements M.R.Thomas.