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Total Number of Pages: 02

Course: B.Tech  
Sub\_Code: RME7D003

7<sup>th</sup> Semester Regular/ Back Examination: 2024-25

SUBJECT: Design of Machine Components

BRANCH(S): Mechanical Engineering

Time: 3 Hours

Max Marks: 100

Q.Code : R098

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right-hand margin indicate marks.

Part-I

Q1 Answer the following questions: (2 x 10)

- What is the criterion to distinguish between thin and thick cylinders?
- What is the factor of safety? Why is it necessary to use during design of any component?
- What are the advantages of V-belts over flat belts?
- What are the advantages of square threads over V threads?
- What are the advantages of 20° full-depth involute teeth gears?
- What is the function of a flywheel?
- What are the cooling systems for engine cylinder?
- What are the design criteria for a piston?
- Why are connecting rods made of I-section?
- What are the basic steps in FEM?

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)

- A plate clutch consists of one pair of contacting surfaces. The inner and outer diameters of the friction disk are 100 and 200 mm respectively. The coefficient of friction is 0.2 and the permissible intensity of pressure is 1 N/mm<sup>2</sup>. Assuming uniform-wear theory, calculate the power-transmitting capacity of the clutch at 750 rpm.
- A vertical screw with single start square threads of 50 mm mean diameter and 12.5 mm pitch is raised against a load of 10 kN by means of a hand wheel, the boss of which is threaded to act as a nut. The axial load is taken up by a thrust collar which supports the wheel boss and has a mean diameter of 60 mm. The coefficient of friction is 0.15 for the screw and 0.18 for the collar. If the tangential force applied by each hand to the wheel is 100 N, find suitable diameter of the hand wheel.
- The following data is given for a rimmed flywheel made of grey cast iron:  
mean radius of the rim = 1 m; thickness of the rim = 100 mm; width of the rim = 200mm  
Number of spokes = 4; cross-sectional area of each spoke = 6500 mm<sup>2</sup>; Speed of rotation = 720 rpm; Mass density of flywheel = 7200 kg/m<sup>3</sup>; Calculate: (i) the maximum tensile stress in the rim; and (ii) the axial stress in each spoke.
- The cylinder of a four-stroke diesel engine has the following specifications:  
Brake power = 3 kW; Speed = 800 rpm; Indicated mean effective pressure = 0.3 MPa  
Mechanical efficiency = 80 %; Determine the bore and length of the cylinder liner.
- With respect to a typical example problem explain the steps of FEA accompanied with a flow chart.

- f) A double-threaded power screw, with ISO metric trapezoidal threads, is used to raise a load of 300 kN. The nominal diameter is 100 mm and the pitch is 12 mm. The coefficient of friction at screw threads is 0.15. Neglecting collar friction, calculate: (i) torque required to raise the load; (ii) torque required to lower the load; and (iii) Efficiency of the screw.
- g) What is the main advantage of overhung crankshafts? Where do you use overhung crankshafts?
- h) An air receiver, consisting of a 500 mm diameter cylinder closed by hemispherical ends, is made of steel FeE 200 and the factor of safety is 2.5. The operating pressure is limited to 3 MPa. Treating the receiver as a thin cylinder, calculate the thickness of the cylinder wall and the hemispherical ends. Neglect the effect of welded joints.
- i) A thick cylinder of internal diameter 160 mm is subjected to an internal pressure 40 N/mm<sup>2</sup>. If the allowable stress in the material is 120 N/mm<sup>2</sup>, find the thickness required.
- j) Derive the stiffness matrix of a spring element with stiffness k subjected to a load of P at one end while the other end is fixed.
- k) Write the expression for static strength, limiting wear load and dynamic load for helical gears and explain various terms used therein.
- l) What are the various methods and materials used in the manufacture of crank shaft?

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** Design a connecting rod for an I.C. engine running at 1800 r.p.m. and developing a maximum pressure of 3.15 N/mm<sup>2</sup>. The diameter of the piston is 100 mm; mass of the reciprocating parts per cylinder 2.25 kg; length of connecting rod 380 mm; stroke of piston 190 mm and compression ratio 6:1. Take a factor of safety of 6 for the design. Take length to diameter ratio for big end bearing as 1.3 and small end bearing as 2 and the corresponding bearing pressures as 10 N/mm<sup>2</sup> and 15 N/mm<sup>2</sup>. The density of material of the rod may be taken as 8000 kg/m<sup>3</sup> and the allowable stress in the bolts as 60 N/mm<sup>2</sup> and in cap as 80 N/mm<sup>2</sup>. **(16)**
- Q4** It is required to design a pair of spur gears with 20° full-depth involute teeth consisting of a 20-teeth pinion meshing with a 50 teeth gear. The pinion shaft is connected to a 22.5 kW, 1450 rpm electric motor. The starting torque of motor can be taken as 150 % of the rated torque. The material for the pinion is plain carbon steel Fe 410 ( $S_{ult} = 410 \text{ N/mm}^2$ ), while the gear is made of grey cast iron FG 200 ( $S_{ult} = 200 \text{ N/mm}^2$ ). The factor of safety is 1:5. Design the gears based on the Lewis equation and using velocity factor to account for the dynamic load. **(16)**
- Q5** An exhaust fan fitted with 900 mm diameter pulley is driven by a flat belt from a 30 kW, 950 r.p.m. squirrel cage motor. The pulley on the motor shaft is 250 mm in diameter and the centre distance between the fan and motor is 2.25 m. The belt is 100 mm wide with a coefficient of friction of 0.25. If the allowable stress in the belt material is not to exceed 2 MPa, determine the necessary thickness of the belt and its total length. Take centrifugal force effect into consideration for density of belt being 950 kg/m<sup>3</sup>. **(16)**
- Q6** A lever loaded safety valve is 70 mm in diameter and is to be designed for a boiler to blow-off at pressure of 1 N/mm<sup>2</sup> gauge. Design a suitable mild steel lever of rectangular cross-section using the following permissible stresses: Tensile stress = 70 MPa; Shear stress = 50 MPa; Bearing pressure intensity = 25 N/mm<sup>2</sup>. The pin is also made of mild steel. The distance from the fulcrum to the weight of the lever is 880 mm and the distance between the fulcrum and pin connecting the valve spindle links to the lever is 80 mm. **(16)**