Exam Date & Time: 02-Dec-2023 (02:30 PM - 05:30 PM)



MANIPAL ACADEMY OF HIGHER EDUCATION

VII SEMESTER B.TECH END SEMESTER EXAMINATIONS, DEC 2023

Design of Mechanical Systems [MME 4042]

Marks: 50

Duration: 180 mins.

PART A

Answer all the questions.

Instructions to Candidates: Answer ALL the questions. Missing data may be appropriately assumed. Assumptions made must be clearly mentioned. Use of design data handbook (hard copy only) is allowed.

- 1) An automobile has a single plate clutch to transmit 33 kW at 2000 rpm. The ratio of mean diameter to radial width of clutch plate is 4.5:1. Determine the diameters of the clutch plate. (5)
- A four-stroke petrol engine runs at a speed of 1600 rpm. The piston diameter is 120 mm. The stroke length is 210 mm. The maximum explosion pressure is 2.25 MPa. I-section is having a flange thickness of 6.5 mm. The density of the connecting rod is 8000 kg/m³. The material for connecting rod is forged steel with ultimate compressive strength of 320 MPa. Determine the maximum stress in the connecting rod and check whether the design is safe.
- 3) A two-speed gearbox is required to transmit 40 kW. The input shaft is rotating at 1500 rpm and the output shaft is to have two different speeds of 500 rpm & 375 rpm. The speed reduction in the first stage is 2. The centre distance is 180 mm. A 4 % variation in output speed is permitted. The gears are having 20⁰ full depth involute profile and are made of 0.3% C heat treated forged steel. The gear pair transmitting power from input shaft to the countershaft has a module of 6 mm. The gear pair which results in an output speed of 500 rpm has a module of 8 mm and the gear pair which results in an output (5) speed of 350 rpm has a module of 5 mm. Determine the number of teeth on all the gears and the actual output speeds of the gearbox. Take the face width as 10 times the module. The gears are subjected to medium shock with 10 hrs/day of service. Draw the layout of the gearbox and design the gear pair that transmits power from input shaft to the countershaft based on Lewis equation.
- The length and diameter of the pin region of an overhung crankshaft are 40 mm and 36 mm, respectively. The crank angle and the connecting rod angle at maximum torque position are 30⁰ and 7.18⁰, respectively. The force on the connecting rod at maximum torque position is 9124 N. The allowable tensile stress and allowable shear stress are 120 MPa and 75 MPa, respectively. Take the thickness of the web as 24 mm. Determine the diameter of the shaft region corresponding to the condition at which maximum explosion pressure is observed.
- 5) Explain any three principles of designing forged components with the help of neat (5) sketches.

PART B

Answer 1 out of 2 questions.

ANSWER ANY ONE OF THE TWO QUESTIONS

6) Design a screw jack to lift a load of 3700 kg through a height of 200 mm. The screw rod is made of steel having yield strength of 300 MPa, in tension & compression and yield shear strength of 180 MPa. The nut is made of phosphor bronze having an allowable bearing pressure of 15 MPa. The cup and body are made of cast iron having an ultimate strength of 500 MPa in compression & 250 MPa in tension. Draw the **front view** of the (25) screw jack on the graph sheet.

OR

7) Design the pulley, beam, wire rope, shaft and bearing for a passenger lift. The number of passengers to be carried are 5 including the operator. Speed of cage is 1 m/s and acceleration / retardation is 1.5 m/s². The shaft mounted on the beams has a span of 300 mm. Each beam has a span of 2 m. The I section beam suggested is ISMB 150, having a depth of 150 mm, flange width of 80 mm, flange thickness of 7.5 mm, web thickness of 5 mm, section modulus of 97 cm³, cross sectional area of 19 cm² and it weighs 15 kg/m. The pitch circle diameter of the pulley is 800 mm. The pulley has 6 arms of cross shaped section having web thickness of 12 mm. Assume the weight of pulley, shaft and bearing assembly as 14 % of the maximum load on the pulley. The pulley has a provision to carry 2 ropes which support the cage and balance weights. The pulley is centrally mounted on the shaft. The shaft assembly is mounted on the beam at a distance of 1.2 m from one end of beam. Take the value of combined shock and fatigue factors to be equal to unity. Draw the front view of the assembly on the graph sheet.

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