Question Paper

Exam Date & Time: 30-Nov-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATION NOVEMBER/DECEMBER 2019
IV SEMESTER B.Sc.(Applied sciences) in engg.
DESIGN OF MACHINE ELEMENTS [IME 242]

Marks: 100 **Duration: 180 mins.**

Answer ANY FIVE FULL questions.
Use of MACHINE DESIGN DATA HAND BOOK is permitted
Clearly mention the referred page/equation/table/figure number etc. for the data selected from Data Hand Book.
Additional data (if any) required may be suitably assumed.
Clearly mention the assumptions made (if any)

1)	A)	Explain the basic design procedure for a machine component with a flow chart.	(5)
	B)	Stating the assumptions made, derive Lewis equation for beam strength of tooth with neat sketch.	(7)
	C)	A shaft of axial flow compressor is exerting radial load of 2.5 kN and thrust load of 1.5 kN on the baring. The diameter of the shaft is 50 mm and rotates at 1000 rpm. It is required to have bearing life of 50 hours/week for 5 years. Suggest a suitable bearing for safe operation of the shaft.	(8)
2)	A)	Explain the meaning of following specifications: i) Material: 55C10 ii) Bearing: SKF 6309 iii) Bolt: 16M39x2	(5)
	B)	A hot rolled 0.3% carbon steel solid shaft 1 m long between the bearings has two gears keyed to it. The gears having 200 mm PCD is located 200 mm to the right of the left hand bearing and receives 20 kW power at 1000 rpm from a gear mounted directly below it. Another gear having 400 mm PCD is located at a distance of 400 mm to the left of the right hand bearing, rotates clockwise as seen from the left hand bearing and delivers power to another gear mounted directly behind it. The gears have 14.5° involute tooth form. Determine the diameter of the shaft. Take C_m = 2, C_t = 1.5. Also, draw the horizontal and vertical bending moment diagrams and check for torsional rigidity.	(15)
3)	A)	With the help of stability curve, explain MCKEE's investigation on hydrodynamic bearing.	(5)
	B)	It is required to design a square key for fixing a gear on a shaft of 25 mm	(5)

diameter. The shaft is transmitting 15 kW power at 720 rpm to the gear. The key is made of steel 50C4 (yield stress = 460 MPa) and the factor of safety is 3. For key material, the yield strength in compression can be assumed to be equal to the yield strength in tension. Determine the dimensions of the key.

C) At the bottom of an elevator shaft a group of 12 identical closed coil helical springs are set in parallel to absorb the shock caused by the falling of the cage in case of failure. The loaded cage weighs 20 kN while the counter weight has a weight of 5 kN. If the loaded cage falls through a height of 3 m from rest, find the maximum stress induced in each spring if it is made of 40 mm diameter steel rod. The spring index is 5. The number of turns in each spring is 4. Take modulus of rigidity G = 82.7 GPa. (10)

4) In mechanical design, when does a component is said to be failed? Discuss various failure modes. (5)

A)

B) The lead screw of a lathe machine has single start ISO square threads of 30 mm outside diameter and 6 mm pitch. It drives the tool carriage exerting an axial load of 1.5 kN. The thrust collar has inside and outside diameters as 30 mm and 50 mm. The carriage moves at a speed of 12 mm/sec. Find power required to drive the screw. Take coefficients of frictions as 0.14. (5)

C) A 50 mm diameter shaft made of SAE grade steel (Yield strength σ_y = 525 MPa, ultimate strength σ_u = 700 MPa, Endurance limit σ_{en} = 350 MPa) and 600 mm span length is simply supported at the ends. It is subjected to fluctuating point load of W to 3W at the center. Determine the maximum cyclic load that can be applied to have an infinite life by using Soderberg's and Goodman's criteria. Assume factor of safety 1.3, a factor for fluctuating mean stress bending load as 0.95, size factor of 0.85 and surface finish factor of 0.9. (10)

5) Design a truck spring to carry a central load of 6000 N with a permissible stress of 280 MPa. The spring supports are 1080 mm apart and central band is 80 mm wide. Assume the ratio of total depth to the width of the spring to be 3. The spring has 12 numbers of leaves out of which 2 are full length leaves. Also find the defection of the spring. (8)

A)

B) A power transmission screw having a square thread of 30 x 6 mm propels a weight of 20 kN at a speed of 3 m/min. The collar has an inside diameter of 30 mm and outside diameter of 60 mm. The coefficient of friction for threads is 0.15 and collar is 0.2. Determine:
i) Power required to drive the screw
ii) Efficiency of the drive
ii) Nature and magnitude of stresses developed in the screw (10)

C) Explain Hertz contact stresses (2)

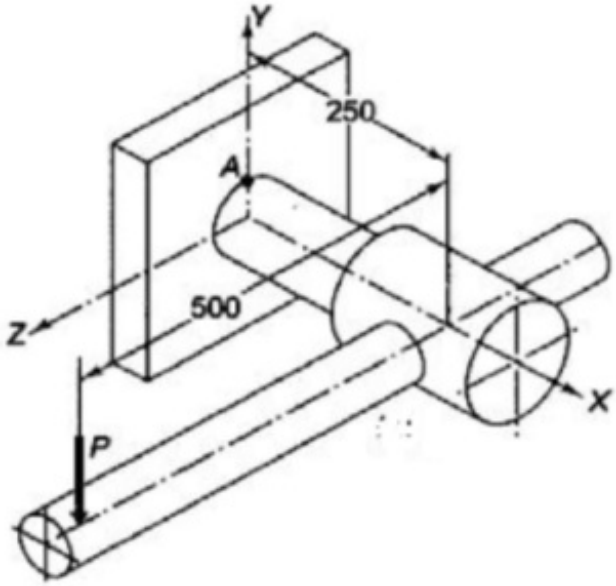
6) Define fatigue. Sketch a neat S-N diagram for steel material and indicate all the salient features. (4)

A)

B) A pair of spur gears with 14.5^0 pressure angle and full depth involute profile (10)

transmits 5 kW with a gear ratio of 3:1 at 1200 rpm of pinion. The pinion is made of C45 steel (untreated) and gear is made of forged steel 0.3% C (untreated). The gears are subjected to medium shocks with 8-10 hrs /day of service. Design the gears based on strength.

C) The shaft of an overhung crank subjected to a force P of 1kN is shown in figure below. The shaft is made of plane carbon steel 45C8 and the tensile strength is 380 MPa. The factor of safety is 2. Determine the diameter of the shaft using maximum shear stress theory. Assume the arm carrying load P is assumed to be rigid and safe to carry the load. (6)



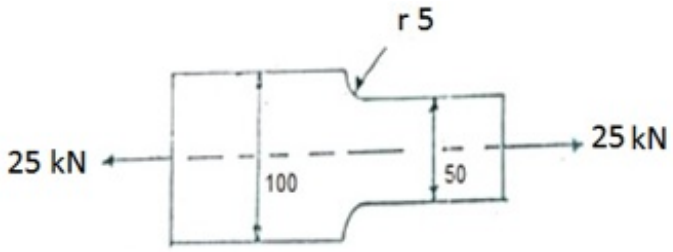
7) Define stress concentration. Explain various parameters that causes stress concentration in materials. (5)

A)

B) A hollow shaft is supported by two bearings placed 1.2 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of a belt having maximum tension 2 kN. Another pulley of 400 mm diameter is placed 200 mm to the left of right bearing and is driven with the help of a motor and belt which is placed at 30^0 to vertical and downwards towards the observer. The angle of contact for both the pulleys is 180^0 and coefficient friction is 0.25. Determine the suitable diameter for hollow shaft having diameter ratio 0.5. The allowable shear stresses are 42 MPa and assume heavy shock condition. (15)

8) A component made of SAE 1045 steel is shown in the figure. It is subjected to a completely reversed axial load of 25 kN. Factor of safety required considering all uncertainties is 2. Take size factor as 0.85, notch sensitivity factor as 0.8. Suggest suitable thickness for the plate by using soderberg and goodman criteria's and comment on the result. (All dimensions in mm). (10)

A)



B) Design a pair of helical gears with starting torque 50% more than the running torque to transmit 15 kW at 10000 rpm of pinion. The gear is to rotate at 2500 rpm. The helix angle is 20°. The pinion is made of C45 steel and the gear is made of forged steel (untreated). Take pressure angle as 20°. Determine face width and module assuming gear ratio as 4:1. (10)

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