Question Paper

Exam Date & Time: 26-Apr-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENES
IV SEMESTER B.Sc.(Applied Sciences) IN ENGINEERING END SEMESTER THEORY EXAMINATION-APRIL/MAY 2019

DESIGN OF MACHINE ELEMENTS [IME 242 - S2]

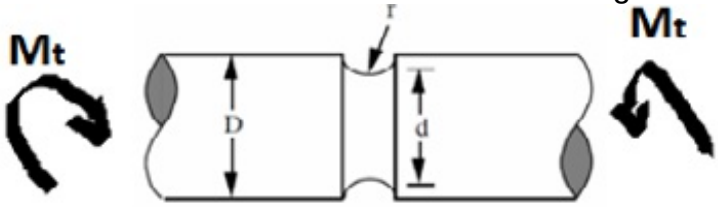
Marks: 100 **Duration: 180 mins.**

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

B) A cover plate is bolted on to the flanged end of a pressure vessel through 6 bolts. The inner diameter of the pressure vessel is 200 mm and is subjected to an internal pressure of 11.5 MPa. Selecting C40 as the material for the bolts determine the size of the bolts, considering initial tension and metal to metal contact. Assume factor of safety = 2.5. (5)

C) A shaft of diameter D has a radial semicircular groove of radius 0.1D as shown in figure. Shaft is made of steel having torsional yield strength of 300 MPa and torsional endurance strength of 210 MPa. The size and the surface factors are 0.85 and 0.87 respectively. The notch sensitivity factor is 0.95. The shaft is to sustain a fluctuating twisting moment (M_t) of +900 Nm to -300 Nm. Find diameter of the shaft taking FOS as 3. (10)



2) A) Briefly explain: (5)
i) Nipping in leaf springs
ii) Surging in springs

B) A spur gear transmits 20 kW of power at 1200 rpm of pinion. The gear ratio is 3:1. The pinion has 18 teeth. The pressure angle is 20^0. The material of pinion is C30 and that of gear is C45. The gear is subjected to medium shock with 8-10 hrs / day of service. Design the gears based on strength. (15)

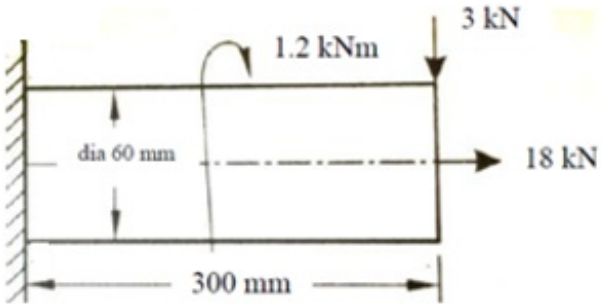
Also, calculate the dynamic load and wear load.

3) With relevant sketches, explain the phenomenon of hydrodynamic lubrication (5)

A)

B) It is required to design a square key for fixing a gear on a shaft of 25 mm 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. (5)

C) A machine member of 60 mm diameter is subjected to a system of loads as shown in figure. Determine the principal stress, maximum shear stress and their planes. Also, determine the normal and tangential stresses on the plane of maximum shear stress. Neglect the shear stress developed due to bending. (10)



4) Write a note on feather key and woodruff key. (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 concentric spring is used for an aircraft engine valve to exert a maximum force of 4 kN under a deflection of 30 mm. Both the springs have same free length, solid height and are subjected to a shear stress of 600 MPa. The spring index for both the springs is 6. G = 82.7 GPa. The diametral clearance is equal to the difference between their wire diameters. Determine: (10)
(i) axial force in each spring
(ii) wire & mean coil diameters of each spring
(iii) number of active coils

5) Explain the meaning of following specifications: (5)
i) Material: X25Cr25Ni12
A) ii) Bearing: SKF 6210
iii) Bolt: 4M24x1.5

B) A hollow shaft is supported by two bearings placed 1.2 m apart. A 600 mm (15)

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.

6) Define factor of safety (FOS). Briefly discuss the parameters which affect the magnitude of FOS in engineering design. (4)

A)

B) 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)

C) A smooth uniaxial rod is subjected to a mean stress of 72 MPa. It has cross-sectional area of 0.0025 m^2 and is made from a steel material (S_y = 550 MPa, S_u = 670 MPa, S_f = 720 MPa) has an endurance limit of 300 MPa. Determine what is the allowable maximum and minimum fluctuating force that will not cause failure in 10^6 cycles according to the Soderberg and Goodman criterion? Coment on the result. (8)

7) With neat sketches explain stages of fatigue failure. (4)

A)

B) A semi-elliptic leaf spring made of 9 leaves is 1.1 m long between the centres of eye. Two of the leaves extend full length of the spring. The leaves are held together by a band 80 mm wide. If the spring is to carry a load of 6.5 kN and permissible stress of the spring material is not to exceed 350 MPa, find the width and thickness of the leaves when leaves are not stresses initially. The deflection of the spring is not to exceed 75 mm. Take E = 207 GPa. (8)

C) 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) Efficiency of the drive
ii) Nature and magnitude of stresses developed in the screw (8)

8) Differentiate between spur and helical gear drive. (5)

A)

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 Pitch Circle Diameter (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 (15)

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.

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