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G-ME-551

B. E. (Fifth Semester) Examination, July-Aug. 2017

(New Course)

(Mechanical Engineering Branch)

MACHINE DESIGN–I

Time Allowed : Four hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : All questions are compulsory. Attempt any two parts of (a), (b), and (c). Design data book by PSG and ISI data sheets are allowed in the exam. Assume any data if missing.

1. (a) Explain theories of failure and its type.

   (b) A rod of a linkage mechanism made of steel 40 Cr$_1$ (S_{ut} = 550 N/mm²) is subjected to a completely reversed axial load of 100 kN. The rod is machined

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on lathe and the expected reliability is 95%. There no stress concentration. Determine the diameter of the rod using a factor of safety of 2 for an infinite life condition.   http://www.prsunotes.com

   (c) A machine component is subject to fluctuating stress that varies from 40 to 100 N/mm². The corrected endurance limit stress for the machine component is 270 N/mm². The ultimate tensile strength and yield strength of material are 600 and 450 N/mm² respectively. Find the factor of safety using :

   (i) Gyrber theory ;

   (ii) Soderberg theory ;

   (iii) Goodman line; and

   (iv) Also, find factor of safety against static failure

2. (a) A flat key is used to connect a pulley to a 45 mm diameter shaft. The standard cross-section of the key is 14 × 9 mm. The key is made of commercial steel (S_{yt} = S_{yc} = 230 N/mm²) and the factor of safety is 3. Determine the length of the key on the basis of shear and compression considerations, if 15 kW power at 360 rpm is transmitted through the keyed joint. Assume (S_{sy} = 0·5 S_{yt}).

(b) A rigid coupling is used to connect a 45 kW, 1440 rpm electric motor to a centrifugal pump. The starting torque of the motor is 225% of the rated torque. There are 8 bolts and their pitch circle diameter is 150 mm. The bolts are made of steel 45C8 ($S_y = 330$ N/mm²) and the factor of safety is 2·5. Determine the diameter of the bolts. Assume ($S_{sy} = 0.577 S_y$). Assume that the bolts are finger-tight in reamed and ground holes.

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(c) It is required to design a knuckle joint to connect two circular rod subjected to an axial tensile force of 50 kN. The rods are co-axial and a small amount of angular movement between their axes is permissible. Design the joint and specify the dimensions of its component. Select suitable materials for the parts.

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3. (a) The layout of a transmission shaft carrying two pulleys B and C and supported on bearings A and D is shown in Fig. 1. Power is supplied to the shaft by means of a verticle belt on pulley B, that is then transmitted to pulley C carrying a horizontal belt. The maximum tension in belt on pulley B is 2·5 kN. The angle of wrap for both the pulleys is 180° and the coefficient of friction of 0·24. The shaft is made of plain carbon

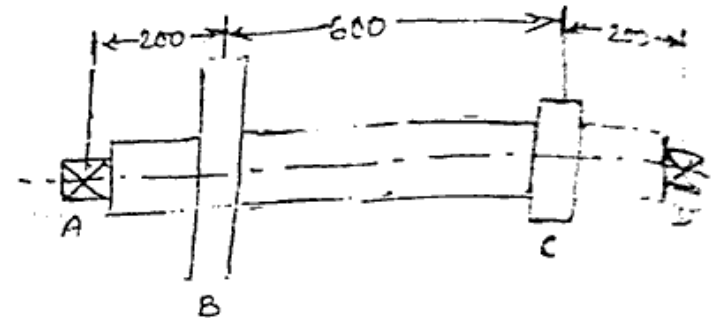steel 30C8 ($S_y = 400$ N/mm²) and the factor of safety is 3. Determine the shaft diameter on strength basis.

Fig. 1

(b) A multi-disk clutch consists of five steel plates and four bronze plates. The inner and outer diameters of friction disks are 75 and 150 mm respectively. The coefficient of friction is 0·1 and the intensity of pressure on friction lining is limited to 0·3 N/mm².

Assuming uniform wear theory, calculate :

(i) the required operating force ; and

(ii) power transmitting capacity of 750 rpm.

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(c) A cone clutch with asbestos friction lining transmits 30 kW power at 500 rpm. The coefficient of friction is 0·2 and the permissible intensity of pressure is 0·35 N/mm². The semi-cone angle α is 12·5°. The outer

diameter is fixed as 300 mm from space limitations. Assuming uniform wear theory, calculate :

  (i) the inner diameter.

  (ii) the face width of the friction lining and

  (iii) the force required to engage the clutch.   8

(a) A steel plate subjected to a force of 5 kN and fixed to a channel by means of three identical bolts is shown in Fig. 2. The bolts are made from plain carbon steel 45C8 (S_{yt} = 380 N/mm²) and the factor of safety is 3. Specify the size of bolts.   8
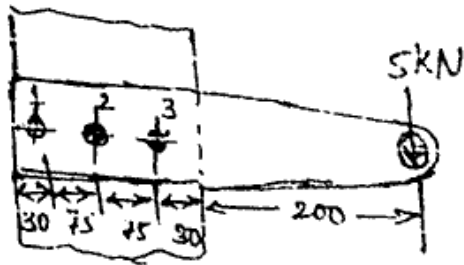

Fig. 2

(b) The nominal diameter of a triple threaded square screw is 50 mm, while the pitch is 8 mm. It is used with collar having outer diameter of 100 mm and inner diameter as 65 mm. The coefficient of friction at the thread surface as well as at the collar surface can be taken as 0·15. The screw is used to raise a

load of 15 kN. Using the uniform wear theory collar friction. Calculate :

  (i) torque required to rasie the load ;

  (ii) torque required to lower the load ; and

  (iii) the force required to raise the load; if apply at a radius of 500 mm.

(c) Explain Collar Friction.

5. (a) Explain different types of welding process.

  (b) Two steel plates, 120 mm wide and 12·5 mm thick are joined together by means of double transverse fillet welds, as shown in fig. 3. The maximum tensile stress for the plates and the welding material should not exceed 110 kN/mm². Find the required length of the weld, if the strength of weld is equal to the strength of the plates.
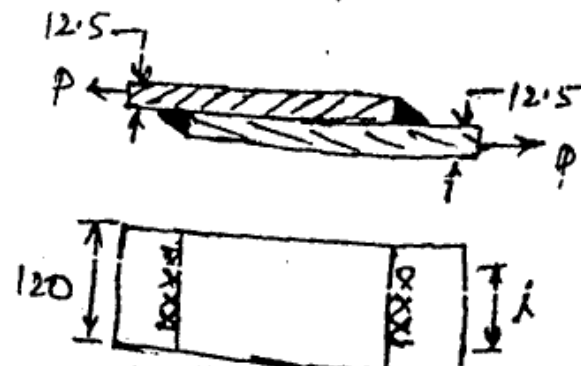
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c) Find the efficiency of the following riveted joints :

(i)   Signal riveted lap joint of 6 mm plates with 20 mm diameters rivets having a pitch of 50 mm.

(ii) Double riveted lap joint of 65 mm plates, with 20 mm diameter rivets having a pitch of 6 mm.

Assume :

(i)   Permissible tensile stress in plate = 120 MPa

(ii) Permissible shearing stress in rivets = 90 MPa

(iii) Permissible crushing stress in rivets = 180 MPa   **8**