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C037611(037)

B. Tech. (Sixth Semester) Examination, April-May 2022

AICTE (~~New~~ Scheme)

(Mechanical Engg. Branch)

DESIGN of MACHINE ELEMENT

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *PSG data book and ISI sheets are allowed. Part (a) of each question is compulsory and attempt any two parts from (b), (c) and (d). All units carry equal 20 marks.*

Unit-I

1. (a) Define the following : 2+2=4

(i) Factor of Safety.

(ii) What is fluctuating stress? Draw a stress-time curve for fluctuating stress.

(b) A component machined from a plate made of steel 45C8 $\left(S_{ut} = 630 \text{ N/mm}^2\right)$ is shown in fig. 1(b). It is subjected to a completely reversed axial force of 50 kN. The expected reliability is 90% and the factor of safety is 2. The size factor is 0·85. Determine the plate thickness t for infinite life, if the notch sensitivity factor is 0·8. 8

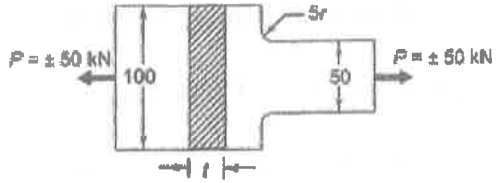

Fig. 1(b)

(c) A rotating bar made of steel 45C8 $\left(S_{ut} = 630 \text{ N/mm}^2\right)$ is subjected to a completely reversed bending stress. The corrected endurance limit of the bar is 315 N/mm^2. Calculate the fatigue strength of the bar for a life of 90,000 cycles. 8

(d) A cantilever beam made of cold drawn steel 40C8 $\left(S_{ut} = 600 \text{ N/mm}^2 \text{ and } S_{yt} = 380 \text{ N/mm}^2\right)$ is shown in Fig. 1(d). The force P acting at the free end varies from –50 N to +150 N. The expected reliability is 90% and the factor of safety is 2. The

notch sensitivity factor at the fillet is 0·9. Determine the diameter 'd' of the beam at the fillet cross-section by using Modified Goodman method. 8

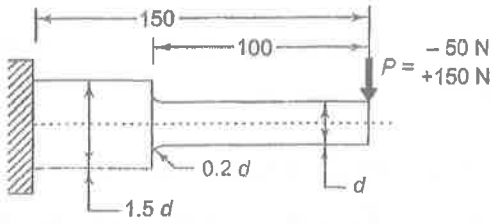

Fig. 1(d)

Unit-II

2. (a) (i) Define a key? Write the function of key. 2

(ii) What is the difference between rigid and flexible couplings? 2

(b) It is required to design a cotter joint to connect two steel rods of equal diameter. Each rod is subjected to an axial tensile force of 50 kN. Design the joint and specify its main dimensions.

Take : $S_{yt} = 400 \text{ N/mm}^2$ and factor of safety for spigot and socket is 6. Factor of safety for cotter is 4. 8

(c) A shaft of 40 mm in diameter, is transmitting 35 kW power at 300 rpm by means of Kennedy keys of 10×10 mm cross-section. The keys are made of steel 45C8 $\left(S_{yt} = S_{yc} = 380 \text{ N/mm}^2\right)$ and the factor of safety is 3. Determine the required length of the keys. 8

(d) A rigid coupling is used to transmit 50 kW power at 300 rpm. There are six bolts. The outer diameter of the flanges is 200 mm, while the recess diameter is 150 mm. The coefficient of friction between the flanges is 0·15. The bolts are made of steel 45C8 $\left(S_{yt} = 380 \text{ N/mm}^2\right)$ and the factor of safety is 3. Determine the diameter of the bolts. Assume that the bolts are fitted in large clearance holes. 8

Unit-III

3. (a) (i) Write the difference between shafts and axles. 2

(ii) Write the difference between dry and wet clutches. 2

(b) A multi-disk clutch consists of five steel plates and four bronze plates. The inner and outer diameters of the friction disks are 75 mm 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/mm^2. Assuming uniform wear theory, calculate :

(i) The required force to engage the clutch; and

(ii) Power transmitting capacity at 750 rpm. 8

(c) The transmission shaft of a gear box supporting two spur gears B and C is shown in Fig. 3(c). The shaft is mounted on two bearings A and D. Ths pitch circle diameters of gears B and C are 900 and 600 mm respectively. The material of the shaft is steel FeE 580 $\left(S_{ut} = 770 \text{ and } S_{yt} 580 \text{ N/mm}^2\right)$. The factors k_b and k_t of ASME code are 1·5 and 2·0 respectively. Determine the shaft diameter using the ASME code. Assume that the gears are connected to the shaft by means of keys. 8

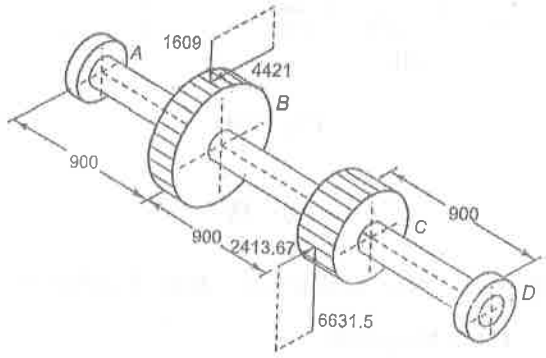

Fig. 3(c)

(d) A line shaft supporting two pulleys A and B is shown in Fig. 3(d). Power is supplied to the shaft by means of a vertical belt on the pulley A, which is then transmitted to the pulley B carrying a horizontal belt. The ratio of belt tension on tight and loose sides is 3:1. The limiting value of tension in the belts is 2·7 kN. The shaft is made of plain carbon steel 40C8 $\left(S_{ut} = 650 \text{ N/mm}^2 \text{ and } S_{yt} = 380 \text{ N/mm}^2\right)$. The pulleys are keyed to the shaft. Determine the diameter of the shaft according to the ASME code if, $k_b = 1 \cdot 5$ and $k_t = 1 \cdot 0$. 8

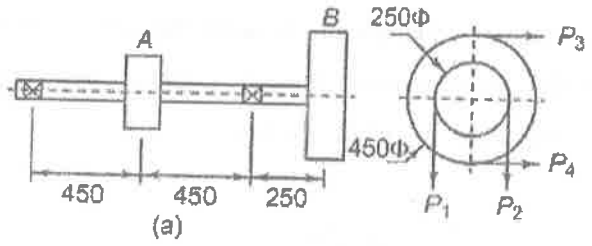

Fig. 3(d)

Unit-IV

4. (a) (i) Write the advantages and disadvantages of threaded joints. 2

(ii) What are the advantages of square threads over trapezoidal threads? 2

(b) 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. 4(b). The bolts are made from plain carbon steel 45C8 $\left(S_{yt} = 380 \text{ N/mm}^2\right)$ and the factor of safety is 3. Specify the size of bolts. 8

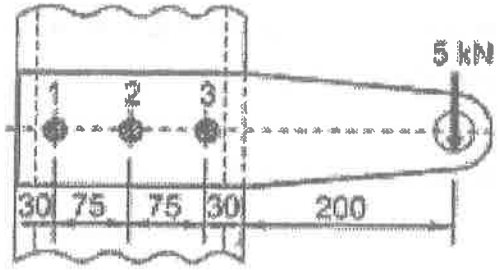

Fig. 4(b)

(c) A wall bracket is attached to the wall by means of four identical bolts, two at A and two at B, as shown in Fig. 4(c). Assuming that the bracket is held against the wall and prevented from tipping about the point C by all four bolts and using an allowable tensile stress in the bolts as 35 N/mm^2, determine the size of the bolts on the basis of maximum principal stress theory. 8

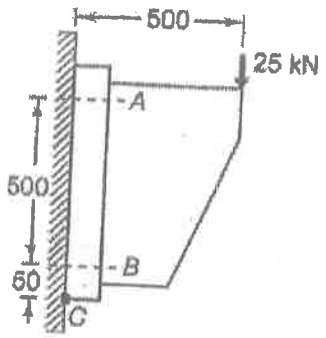

Fig. 4(c)

(d) 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 the screw threads is 0·15. Neglecting collar friction, calculate :

(i) Torque required to raise the load.

(ii) Torque required to lower the load.

(iii) Efficiency of the screw. 8

Unit-V

5. (a) (i) What is the relationship between leg and throat of fillet weld? 2

(ii) What are the different types of rivet heads? Give their applications. 2

(b) A steel plate, 100 mm wide and 10 mm thick, is joined with another steel plate by means of single transverse and double parallel fillet welds, as shown in Fig. 5 (b). The strength of the welded joint should be equal to the strength of the plates to be joined. The permissible tensile and shear stresses for the weld material and the plates are 70 and 50 N/mm^2 respectively. Find the length of each parallel fillet weld. Assume the tensile force acting on the plates as static. 8

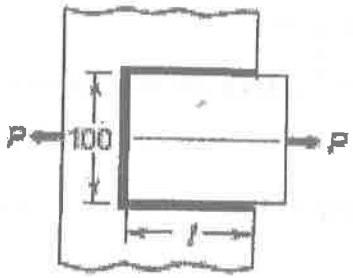

Fig. 5(b)

(c) A cylindrical pressure vessel with a 1·5 m inside diameter is subjected to internal steam presure of 1·5 MPa. It is made from steel plate by triple-riveted double-strap longitudinal butt joint with equal

straps. The pitch of the rivets in the outer row is twice of the pitch of the rivets in the inner rows. The rivets are arranged in zigzag pattern. The efficiency of the riveted joint should be at least 80%. The permissible stresses for the plate and rivets in tension, shear and compression are 80, 60 and 120 N/mm^2 respectively. Assume that the rivet in double shear is 1·875 times stronger than in single shear. Design the joint and calculate : 8

(i) thickness of the plate;

(ii) diameter of rivets;

(iii) pitch of rivets;

(iv) distance between the rows of rivets;

(v) margin;

(vi) thickness of the straps; and efficiency of the joint.

Draw a neat sketch of the riveted joint showing calculated values of dimensions.

(d) A bracket, attached to a vertical column by means of four identical rivets, is subjected to an eccentric force of 25 kN as shown in Fig. 5(d). Determine the diameter of rivets, if the permissible shear stress is 60 N/mm^2. 8

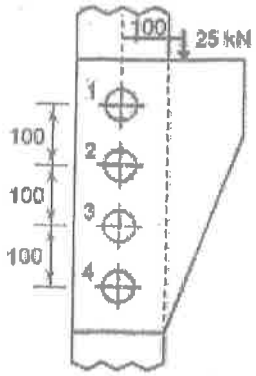

Fig. 5(d)