Q.6 i. How does the function of a brake differ from that of a clutch? **2**

ii. A differential band brake, as shown in Fig.1, has an angle of contact of 225°. **8** The band has a compressed woven lining and bears against a cast iron drum of 350 mm diameter. The brake is to sustain a torque of 350 N-m and the coefficient of friction between the band and the drum is 0.3. Find:
(a) The necessary force (P) for the clockwise and anticlockwise rotation of the drum; and
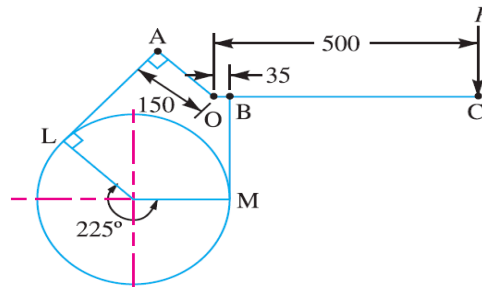(b) The value of 'OA' for the brake to be self-locking, when the drum rotates clockwise.

Figure 1

All dimensions in mm

OR iii. The block brake, as shown in Fig. 2, provides a braking torque of 360 N-m. **8** The diameter of the brake drum is 320 mm. The coefficient of friction is 0.3. Find:
(a) The force (P) to be applied at the end of the lever for the clockwise and counter clockwise rotation of the brake drum
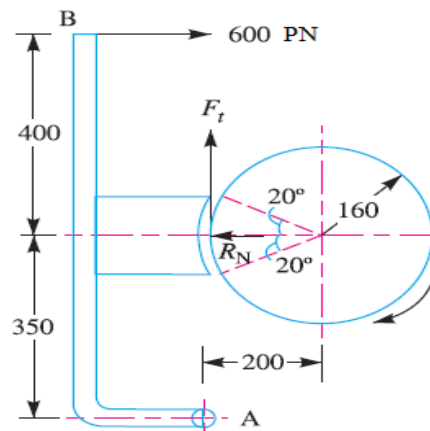(b) The location of the pivot or fulcrum to make the brake self-locking for the clockwise rotation of the brake drum.

Figure 2

All dimensions in mm

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Duration: 3 Hrs.   Maximum Marks: 60

Note: 1. All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.
2. Design data book is permitted.

Q.1 i. When the length of the journal is equal to the diameter of the journal, then the bearing is said to be a **1**
(a) Short bearing (b) Long bearing (c) Medium bearing (d) Square bearing

ii. In thrust bearings, the load acts **1**
(a) Along the axis of rotation (b) Parallel to the axis of rotation
(c) Perpendicular to the axis of rotation (d) In any direction

iii. A spur gear with pitch circle diameter D has number of teeth T. The module m is defined as **1**
(a) $m = D / T$ (b) $m = T / D$ (c) $m = \pi D/T$ (d) $m = D.T$

iv. Lewis equation in spur gears is used to find the **1**
(a) Tensile stress in bending (b) Shear stress
(c) Compressive stress in bending (d) Fatigue stress

v. The cylinders are usually made of **1**
(a) Cast iron or cast steel (b) Aluminium
(c) Stainless steel (d) Copper

vi. The rocker arm is used to actuate the inlet & exhaust valves motion as directed by the **1**
(a) Cam and follower (b) Crank
(c) Crankshaft (d) None of these

vii. The energy absorb by brake is always _____. **1**
(a) Kinetic (b) Kinetic or potential
(c) Potential (d) Strain Energy

viii. The capacity of a brake depends upon **1**
(a) The unit pressure between the braking surfaces,
(b) The coefficient of friction between the braking surfaces,
(c) The peripheral velocity of the brake drum
(d) All of these

ix. In case of a multiple disc clutch, if n_1 are the number of discs on the driving **1** shaft and n_2 are the number of the discs on the driven shaft, then the number of pairs of contact surfaces will be

(a) $n_1 + n_2$ (b) $n_1 + n_2 + 1$ (c) $n_1 + n_2 - 1$ (d) None of these

x. A jaw clutch is essentially a   **1**

(a) Positive action clutch   (b) Cone clutch

(c) Friction clutch   (d) Disc clutch

Q.2   i. What are journal bearings? Give a classification of these bearings?   **3**

    ii. A full journal bearing of 50 mm diameter and 100 mm long has a bearing **7** pressure of 1.4 N/mm^2. The speed of the journal is 900 r.p.m. and the ratio of journal diameter to the diametral clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75°C may be taken as 0.011 kg/m-s. The room temperature is 35°C.

Find:

(a) The amount of artificial cooling required.

(b) The mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10°C.

Take specific heat of the oil as 1850 J/kg/°C & Heat dissipation coefficient (C) = 280 W/m^2/ºC.

OR   iii. A 80 mm long journal bearing supports a load of 2800 N on a 50 mm diameter **7** shaft. The bearing has a radial clearance of 0.05 mm and the viscosity of the oil is 0.021 kg / m-s at the operating temperature. If the bearing is capable of dissipating 80 J/s, determine the maximum safe speed.

Q.3   i. What is the merits and demerits of gear drives?   **3**

    ii. A gear drive is required to transmit a maximum power of 22.5 kW. The **7** velocity ratio is 1:2 and r.p.m. of the pinion is 200. The approximate centre distance between the shafts may be taken as 600 mm. The teeth has 20° stub involute profiles. The static stress for the gear material (which is cast iron) may be taken as 60 MPa and face width as 10 times the module. Find the module, face width and number of teeth on each gear.

OR   iii. A helical cast steel gear with 30° helix angle has to transmit 35 kW at 1500 **7** r.p.m. If the gear has 24 teeth, determine the necessary module, pitch diameter and face width for 20° full depth teeth. The static stress for cast steel may be taken as 56 MPa. The width of face may be taken as 3 times the normal pitch. What would be the end thrust on the gear?

Q.4   i. The cylinder of a four-stroke diesel engine has the following specifications: **4**

Cylinder bore = 150 mm

Maximum gas pressure = 3.5 MPa

Cylinder material = Grey cast iron FG 200(Sut = 200 N/mm^2)

Factor of safety = 5, Poisson's ratio = 0.25

Determine the thickness of the cylinder wall. Also, calculate the apparent and net circumferential and longitudinal stresses in the cylinder wall.

    ii. The bore of a cylinder of the fourstroke diesel engine is 150 mm. The **6** maximum gas pressure inside the cylinder is limited to 3.5 MPa. The cylinder head is made of grey cast iron FG200 (Sut = 200 N/mm^2) and the factor of safety is 5.

Determine the thickness of the cylinder head. Studs are used to fix the cylinder head to the cylinder and obtain a leak proof joint. They are made of steel FeE 250 (S_{yt} = 250 N/mm^2) and the factor of safety is 5. Calculate.

(a) Number of studs   (b) Nominal diameter of studs

(c) Pitch of studs

OR   iii. Determine the dimensions of cross-section of the connecting rod for a diesel **6** engine with the following data:

Cylinder bore = 100 mm

Length of connecting rod = 350 mm

Maximum gas pressure = 4 MPa

Factor of safety = 6

Q.5   i. Describe, with the help of a neat sketch, a centrifugal clutch?   **3**

    ii. A multiple disc clutch, steel on bronze, is to transmit 4.5 kW at 750 r.p.m. The **7** inner radius of the contact is 40 mm and outer radius of the contact is 70 mm. The clutch operates in oil with an expected coefficient of 0.1. The average allowable pressure is 0.35 N/mm2. Find:

(a) The total number of steel and bronze discs

(b) The actual axial force required

(c) The actual average pressure

(d) The actual maximum pressure.

OR   iii. A centrifugal clutch is to be designed to transmit 15 kW at 900 r.p.m. The **7** shoes are four in number. The speed at which the engagement begins is 3/4th of the running speed. The inside radius of the pulley rim is 150 mm. The shoes are lined with Ferrodo for which the coefficient of friction may be taken as 0.25. Determine: (a) Mass of the shoes   (b) Size of the shoes

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Marking Scheme
AU3CO13/ME3CO12 Machine Design-II

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Q.1   i.   When the length of the journal is equal to the diameter of the journal, **1**
then the bearing is said to be a
(d) Square bearing

ii.   In thrust bearings, the load acts   **1**
(a) Along the axis of rotation

iii.   A spur gear with pitch circle diameter D has number of teeth T. The **1**
module m is defined as
(a) $m = D / T$

iv.   Lewis equation in spur gears is used to find the   **1**
(c) Compressive stress in bending

v.   The cylinders are usually made of   **1**
(a) Cast iron or cast steel

vi.   The rocker arm is used to actuate the inlet & exhaust valves motion as **1**
directed by the
(a) Cam and follower

vii.   The energy absorb by brake is always _____.   **1**
(b) Kinetic or potential

viii.   The capacity of a brake depends upon   **1**
(d) All of these

ix.   In case of a multiple disc clutch, if n_1 are the number of discs on the **1**
driving shaft and n_2 are the number of the discs on the driven shaft, then
the number of pairs of contact surfaces will be
(c) $n_1 + n_2 - 1$

x.   A jaw clutch is essentially a   **1**
(a) Positive action clutch

Q.2   i.   Definition of journal bearings   1 mark   **3**
Classification of these bearings   2 marks

ii.   (a) Amount of Artificial cooling: 4 marks   **7**
    Coeff. of friction = 0.00433
    W = 7000 N
    Velocity = 2.36 m/s
    Qg = 71 J/s, Qg = 28 J/s
    Amount of artificial cooling = 43.5 J/s
(b) Mass of lubricating oil :   3 marks
    m = 0.233 kg/min

OR   iii.   For pressure p = 0.7 N/mm2   1 mark   **7**
For Coeff. of friction = 495 N/10^8+0.002   2 marks
For heat generated Q_g = 3628N^2/10^8+0.01466N   2 marks
For N = 1295 rpm   2 marks

Q.3   i.   Merits and demerits of gear drives   **3**

ii.   For Diameters D_P = 400 mm; D_G = 800 mm   2 marks   **7**
For Module; m = 8 mm   2 marks
For face width ; b = 80 mm   2 marks
For No of Teeth; T_P = 50 ,T_G = 100   1 mark

OR   iii.   For Module; m = 6 mm   2 marks   **7**
For face width ; b = 50 mm   2 marks
For Diameters D_G = 144 mm   2 marks
For Axial load = 1790 N   1 mark

Q.4   i.   Thickness of cylinder wall = 12 mm   1 mark   **4**
Circumferential stress & Longitudinal stress = 21.88 MPa & 10.13
MPa   2 marks
Net Circumferential stress & Longitudinal stress = 19.35 MPa 4.66
MPa   1 mark

ii.   Thickness of cylinder head   1 mark   **6**
T_h = 18 mm
Number of studs   1 mark
Z = 6
Nominal diameter of studs   2 marks
d = 20 mm
Pitch of studs   2 marks
p = 110 mm

OR   iii.   Critical load P_C = 188495 N   1 mark   **6**
Thickness t = 8 mm   1 mark
Dimensions of Cross-section   4 marks
B = 4t =32 mm
H = 5t = 40 mm
Dimension (B/H) of section at big end = 32 mm x 48 mm
Dimension (B/H) of section at middle end = 32 mm x 40 mm
Dimension (B/H) of section at small end = 32 mm x 34 mm

Q.5   i.   Centrifugal clutch with sketch   **3**

ii.   (a) Total no of steel and bronze dics = 3 & 2   2 marks   **7**
(b) Axial force = 2604 N   2 marks
(c) Average pressure p = 0.25 MPa   1 mark
(d) Maximum pressure = 0.345 MPa   2 marks

OR   iii.   (a) Mass of the shoes m = 2.27 kg   4 marks   **7**
                    (b) Size of the shoes b = 67.4 mm   3 marks

Q.6   i.   Function of a brake differ from that of a clutch   **2**

        ii.   Tensions T_1 = 2886 N, T_2 = 886 N   3 marks   **8**
              P = 804 N   2 marks
              Valve of 'OA' for the brake to be self locking, when the drum rotates
              clockwise for OA = 114 mm   3 marks
              3 marks

OR   iii.   For given values   1 mark   **8**
              For R_N calculation   2 marks
              Force (P) for clockwise rotation   2 marks
              Force (P) for counter clockwise rotation   2 marks
              Location of the pivot or fulcrum to make the brake self-locking
                                            1 mark

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