



**MAULANA ABUL KALAM AZAD UNIVERSITY OF
TECHNOLOGY, WEST BENGAL**

**Paper Code : ME-603
MACHINE DESIGN**

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own
words as far as practicable.*

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

10 × 1 = 10

i) In a full journal bearing, the angle of contact of the bearing with the journal is

- | | |
|---------|---------|
| a) 120° | b) 180° |
| c) 270° | d) 360° |

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[Turn over

- ii) In thrust bearing, the load acts
- along the axis of rotation
 - parallel to the axis of rotation
 - perpendicular to the axis of rotation
 - in any direction.
- iii) The worm gears are widely used for transmitting power at velocity ratios between non-intersecting shafts.
- high
 - low
- iv) A type of brake commonly used in motor car is a
- shoe brake
 - band brake
 - internal expanding brake
 - band and block.
- v) The tapered roller bearings can take
- radial load only
 - axial load only
 - both radial and axial loads
 - none of these.
- vi) Which of the following is antifriction bearing ?
- journal bearing
 - collar bearing
 - needle bearing
 - pedestal bearing.
- vii) The backlash for spur gears depends upon
- module
 - tooth profile
 - pitch line velocity
 - both (a) and (b).

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- viii) The contact ratio for gears is
- zero
 - less than one
 - greater than one
 - none of these.
- ix) Lewis equation in spur gears is used to find the
- Tensile stress in bending
 - shear stress
 - compressive stress in bending
 - fatigue stress.
- x) A brake commonly used in railway train is
- shoe brake
 - band brake
 - band and block brake
 - internal expanding brake.

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. A multi-disc clutch has three discs on the driving shaft and two on the driven shaft. The inside diameter of the contact surface is 120 mm. The maximum pressure between the surface is limited to 0.1 N/mm^2 . Design the clutch for transmitting 25 kW at 1575 r.p.m. Assume uniform wear condition and coefficient of friction as 0.3.

3. Explain the functional difference between flywheel and governor.
4. Explain the functional difference between a brake and clutch. What are self-energizing and self-locking block brakes ? $2 + 3$
5. A triple threaded worm has teeth of 6 mm module & pitch circle diameter of 60 mm. If the worm has 30 teeth, find (i) lead angle, (ii) velocity ratio, (iii) centre distance of the worm gearing system. $2 + 1\frac{1}{2} + 1\frac{1}{2}$
6. Draw and explain the Stribeck curve. What is Petroff's equation ? What is Reynolds equation ? $3 + 1 + 1$

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. A centrifugal clutch consists of 4 shoes. Each shoe has a mass of 1.6 kg and subtends an angle of 45° at the centre of rotation. In the engaged position the distance of C.G. of the shoes from the axis is 120 mm. The inner radius of the pulley rim is 150 mm. The shoes are lined with bonded asbestos woven with fine brass wire having $\mu = 0.25$ and allowable design pressure, $P = 0.1 \text{ N/mm}^2$. The pre-load in the spring is adjusted such that the

spring force at the beginning of the engagement is 700 N. The running speed is 1440 rpm. Determine :

- The speed at which the engagement begins
- Size of each shoe
- The power transmitted by the clutch at 1440 r.p.m.

5 + 5 + 5

- Explain with diagram the principle of hydrodynamic lubrication.
 - What is Sommerfeld number in bearing lubrication ?
 - A full journal bearing of 50 mm diameter and 100 mm long has a bearing 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:
 - The amount of artificial cooling required
 - The mass of the lubricating oil required, if the difference between the outlet and inlet temperatures of the oil is 10°C . Take specific heat of the oil as $1850 \text{ J/kg}^\circ\text{C}$.

3 + 2 + 10

- Design a cast iron flywheel used for a four stroke IC engine developing 180kW at 240 r.p.m. The hoop stress developed in the flywheel is 5.2 MPa , the total fluctuation of speed is to be limited to 3% of the mean speed. the work done during the power stroke is $1/3$ more than the average work done during the whole cycle. The maximum torque on the shaft is twice the mean torque. The density of cast iron is 7220 kg/m^3 .

- Show that for a solid disc flywheel the tangential and radial stress are equal at their maximum values.

10 + 5

- A gear drive containing spur gears in external gearing arrangement, transmits a maximum power of 22.5 kW. The speed ratio is 1:2 and speed of the pinion is 200 rev/min. The approximate centre to centre distance between the shafts is 600 mm. The tooth has 20° stub involute profile. For which Lewis form factor,

$$Y = \pi \left[0.175 - \frac{0.841}{z} \right], \text{ where } z \text{ is number of teeth. And velocity factor, } C_v = \frac{3}{3 + v}, \text{ where } v \text{ is in m/s.}$$

The static stress for gear materials 60 MPa (for both gear and pinion) and face width is 10 times that of module. Determine the module, face width and number of teeth on each gear. Take flexural endurance limit as 84 MPa . Take service factor, $C_o = 1$.

Check the design for dynamic and wear loads. Take deformation or dynamic factor, i.e. a factor depending upon machining error, $C = 80$ and load stress factor for fatigue, $K_w = 1.4$.

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11. a) The piston rod of a hydraulic cylinder (thick cylinder) exerts an operating force of 10 kN. The friction due to piston packing and stuffing box is equivalent to 10% of the operating force. The pressure in the cylinder is 10 MPa. The cylinder is made of cast iron FG200 and the factor of safety is 5. Determine the inner diameter and the thickness of the cylinder. 6
- b) A differential band brake is shown in Fig. 1 the width and the thickness of the steel band are 100 mm and 3 mm respectively and the maximum tensile stress in the band is 50 N/mm^2 . The coefficient of friction between the friction lining and the brake drum 0.25. Calculate -
- tension in the band
 - the actuating force
 - the torque capacity of the brake.
- Also find out whether the brake is self-locking.

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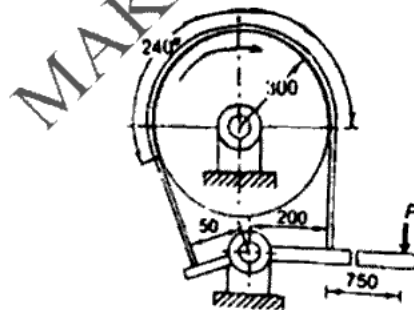


Fig. 1

(All dimensions are in mm)