



- a) 1.5 to 2 (b) 10 to 12 (c) 4 to 5 (d) 1:1
- l) The listed life of a rolling bearing, in a catalogue, is the (1)  
 (a) minimum expected life (b) maximum expected life (c) average life (d) none
- m) Cylinder thickness is calculated on the basis of.....stress (1)  
 (a) radial (b) residual stress (c) whipping stress (d) circumferential hoop stress
- n) The minimum number of teeth on pinion to avoid interference in rack and pinion (1)  
 is (a) 15 (b) 18 (c) 21 (d) 24

**Attempt any four questions from Q-2 to Q-8**

**Q-2 Attempt all questions**

- a) Discuss the various causes of gear tooth failure and write the possible remedies to overcome gear tooth failure. (04)
- b) A pair of helical gears are to transmit 15 kW, The teeth are 20° stub in diametral plane and have a helix angle of 45°. The gear has 320 mm pitch diameter. If the gears are made of cast steel having allowable static strength of 100 MPa, determine a suitable module and face width from static strength consideration and check the gears for wear. ( $\sigma_{es} = 618 \text{ MPa}$ , tooth form factor for 20° stub sytem  $y_p = 0.175 - 0.841/T_E$ ,  $C_v = 0.75/0.75+v$ ,  $E_p = E_G = 200 \cdot 10^3 \text{ N/mm}^2$ ) (10)

**Q-3 Attempt all questions**

- a) Define formative number of teeth of bevel gear and also sketch the tooth terminology of bevel gears with neat labelled. (07)
- b) A pair of bevel gears connect at right angles and transmits 9 kW. Determine the required module and gear diameter for the following specifications: (07)

Particulars	Pinion	Gear
No. of teeth	21	60
Material	Semi-steel	Grey C I.
BHN	200	160
Speed	1200 rpm	420 rpm
Tooth profile	14-1/2° composite	14-1/2° composite
$\sigma_o$	85 MPa	55 MPa

Check the gears for dynamic as well as for wear load.

(Take,  $y_p = y_G = 0.124 - 0.684/T_E$ ,  $C_v = 6/6+v$ , error action,  $e = 0.055 \text{ mm}$ ,  $K = 0.107$ ,  $E_p = 210 \cdot 10^3 \text{ N/mm}^2$ ,  $E_G = 84 \cdot 10^3 \text{ N/mm}^2$ )

**Q-4**

- A three stage gear box with twelve speeds is to be designed based on R 10 series with minimum spindle speed of 125 rpm. The second stage consists of three speed steps. The electric motor is connected to the gear box through a belt drive and runs at 1500 rpm and transmits of 5 kW. The reduction through belt drive between motor and input shaft = 1:2. Determine: (14)
- Standard speed
  - Draw structure and speed diagram for the arrangement
  - Determine no. of teeth in each gear
- (For R 10 series standard speed as: 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250 & 1500 rpm)

**Q-5 Attempt all questions**

- a) Explain the principle of hydrodynamic journal bearing. (07)



- b) Design a full hydrodynamic journal bearing with the following specifications for machine tool applications: (07)

Journal diameter	75 mm
Radial Load	10 kN
Journal Speed	1440 rpm
Minimum oil film thickness	22.5 microns
Inlet Temperature	40°C
Bearing Material	Babbitt

Determine the length of bearing and select a suitable oil film for this applications.

(Take, Bearing pressure = 2 N/mm<sup>2</sup>, S = 0.264, CFV = 5.79, FV = 3.99)

Q-6

**Attempt all questions**

- a) Derive the expression for stribeck's equation for rolling contact bearing. Write the limitations of equation. (07)
- b) Explain bearing life, dynamic & equivalent load carrying capacity of rolling contact bearing. (07)

Q-7

**Attempt all questions**

- a) Explain thermal consideration while designing worm and worm wheel drive. (04)
- b) Design a cast iron piston for a single acting four stroke diesel engine with the following data: (10)

Cylinder bore	300 mm
Length of stroke	450 mm
Speed	300 rpm
Indicated mean effective pressure	0.85 MPa
Maximum gas pressure	5 MPa
Fuel consumption	0.30 kg/BP/hr
H.C.V. of fuel	44,000 kJ/kg

Assume suitable data if required.

(Take, for CI piston,  $\sigma_t = 40 \text{ N/mm}^2$ ,  $\eta_m = 80\%$ ,  $C = 0.05$ ,  $k = 46.6 \text{ W/m}^2\text{ }^\circ\text{C}$ ,  $T_c - T_e = 220 \text{ }^\circ\text{C}$ )

(For CI piston rings,  $\sigma_t = 90 \text{ N/mm}^2$ ,  $p_w = 0.035 \text{ MPa}$ ), (for piston skirt,  $p_b = 0.45 \text{ Pa}$ ,  $\mu = 0.1$ , for piston), (for piston pin,  $p_{b1} = 30 \text{ MPa}$ ,  $\sigma_t = 140 \text{ N/mm}^2$ )

Q-8

**Attempt all questions**

- a) What are the desirable properties of cylinder materials and write the advantages of aluminium alloy piston over cast iron piston. (04)
- b) The cylinder of 4-stroke diesel engine has the following specifications: (10)  
 Brake power = 7.5 kW, Speed = 1400 rpm, Indicate mean effective pressure = 0.35 MPa, Mechanical efficiency = 80 %, Maximum gas pressure = 3.5 MPa.  
 The cylinder liner and head are made of grey cast iron FG 260 ( $\sigma_{ut} = 260 \text{ N/mm}^2$  &  $\mu = 0.25$ ), The studs are made of plain carbon steel 40 C 8 ( $S_{yt} = 380 \text{ N/mm}^2$ ), F. S. for all parts = 6. Calculate:  
 (i) bore and length of cylinder liner (ii) thickness of the cylinder liner  
 (iii) thickness of the cylinder head (iv) size, number and pitch of studs.

