QUESTION BANK

Chapter:-6 Design of IC Engine Components

Que: 1 Design a cast iron piston for a single acting four stroke diesel engine for following data:
Cylinder bore = 100 mm, stroke = 125 mm, Pmax = 5.8 N/mm², pmean = 0.8 N/mm², ηm = 85 %, speed = 1500 rpm, Fuel consumption = 0.16 kg/BP/hr, H.C.V. = 40 x 10³ kJ/kg, Constant C = 0.05, K = 46.6 W/m⁰K, σt (C.I.) = 30 N/mm² For piston : μ = 0.1, pb = 0.45 N/mm²
For piston rings: pw = 0.030 N/mm², σr = 80 N/mm²
For piston pin: pb = 20 N/mm², σb = 120 N/mm², τ = 60 N/mm²

Que: 2 The cylinder of a four stroke diesel engine has the following specifications:
Brake power = 7.5 kW; Speed = 1400 rpm; Maximum gas pressure = 3.5 MPa; Indicated mean, effective pressure = 0.35 MPa; Mechanical efficiency = 80 %; The cylinder liner and head are made of grey cast iron (Sut = 260 MPa and μ = 0.25). The factor of safety for all parts is 6.
Calculate:
1. Bore and length of the cylinder liner
2. Thickness of the cylinder liner (Take, C= 3.2 mm)
3. Thickness of the cylinder head

Que: 3 What are the merits and demerits of wet and dry cylinder liners?

Que: 4 Design a cast iron piston for single acting four stroke engine for following specification
Cylinder Bore = 110 mm, Stroke = 130 mm, Maximum gas pressure = 5N/mm²
Brake mean effective pressure = 0.5 N/mm², Fuel consumption = 0.2 kg/kw/hr, speed =2000rev/min. Assume suitable data for C, permissible tensile stress is 40 N/mm², HCV=41870 KJ/kg, K for C.I. = 46.6 Permissible tensile stress or piston ring is 100 N/mm², permissible tensile stress for pin is 150 N/mm²

Que: 5 A four stroke diesel engine has the following specification:
Cylinder bore = 200 mm
Stroke = 240 mm
Speed = 850 rpm
Indicated mean, effective pressure = 0.5 Mpa
Mechanical efficiency = 80%
Maximum gas pressure = 5 Mpa
Fuel consumption = 0.27 kg per BP per hour
Higher calorific value of fuel = 47000 kJ/kg
Assume that 5% of the total heat developed in the cylinder is transmitted by the piston. The piston is made from gray cast iron FG240 having Sut= 240 Mpa and thermal conductivity factor of 46.6 W/m⁰C. Assume a factor of safety as 5. The temperature difference between the center and the edge of the piston head is 220⁰C. Calculate the thickness of the piston head. Suggest if the piston requires the presence of ribs. If so, suggest the number of ribs and their thickness. Also state whether a cup is required on the piston head and if so, what would be its radius.

Que: 6 Why ‘I’ section is chosen for the connecting rod in the design of I.C.Engine?

Que: 7 Discuss about various section of connecting rod.

Que: 8 Describe the criteria for deciding the size of suction and exhaust valve of an I.C. engine.
Que:9 Design a connecting rod for a 4 – stroke petrol engine from the following data:
- Cylinder bore = 100 mm ; Stroke length = 140 mm
- Engine speed = 1500 rpm ; Possible over speed of engine = 2500 rpm
- Maximum explosion pressure = 2.5 MPa ; Weight of reciprocating parts = 18.5 N
- Length of connecting rod = 315 mm ; Yield strength of connecting rod material = 320 MPa
- Factor of safety = 5 ; Permissible bearing pressure for big end = 12.5 MPa
- Permissible bearing pressure for small end = 15 MPa

Que:10 Design a connecting rod for four stroke petrol engines for following data.
- Piston diameter =0.1 m ; Stroke=0.14 m, ; Length of C.R. =0.315 m
- Weight of reciprocating part =18.2 N ; Speed = 1500 rpm with over speed 2500
- Compression ratio 4:1; Maximum explosion pressure = 2.45 MPa. F.O.S. =5 , For connecting rod
- $\sigma_{\text{yield}} = 380 \text{ N/mm}^2$, $\sigma_{\text{ultimate}} = 580 \text{ N/mm}^2$

Que:11 Design an overhung Crank shaft with two main bearings for an I. C. engine with the following data:
- Cylinder bore = 250 mm ii. Stroke length = 300 mm
- Flywheel weight = 27 kN iv. Maximum pressure = 2.5 N/mm²
- Maximum torque at crank rotation = 1.7 N/mm² 30o the pressure at that instant.

Que:12 Design a tubular type pushrod for operating an exhaust valve of 4 stroke I. C. engine using the following data:
- Maximum force required to open the exhaust valve = 900 N
- Ratio of lp/lw for rocker arm = 1.2
- Length of push rod = 110 mm
- Ratio of inner diameter to outer diameter for tubular push rod = 0.75
- Required factor of safety = 04
- Compressive yield strength for mild steel push rod = 350 N/mm²
- Modulus of elasticity for mild steel = $210 \times 10^3 \text{ N/mm}^2$

Que:13 Draw a neat sketch of the connecting rod and explain its constructional detail.

Que:14 Following data is given for a diesel engine:
- Cylinder bore = 100 mm. Length of connecting rod = 350 mm, FOS = 6,
- Maximum gas pressure = 4 MPa, l/d Ratio for piston pin bearing = 2,
- l/d Ratio for crank pin bearing = 1.3,
- Allowable bearing pressure for piston pin bearing = 12 MPa
- Allowable bearing pressure for crank pin bearing = 7.5 MPa
- Determine: (i) Dimensions of cross section of the connecting rod (ii) Dimensions of small and big end bearings of connecting rod.
Chapter: 1 Spur Gear

Que: 1 Explain different modes of gear teeth failures, stating their reasons and remedies.
Que: 2 Explain Pitting and Scoring for gear tooth failure and the gear material and heat treatment.
Que: 3 Answer the following questions.
   (1) What do you mean by interference and undercutting of gear? How it can be avoided?
   (2) What is contact ratio? How it can be increased?
Que: 4 Design a spur gear pair to transmit 15 kW power from an electric motor shaft running at 1500 rpm to a machine shaft from the following specifications.
   Tooth system = 200 pressure angle full depth involutes
   Number of teeth on pinion = 25
   Speed reduction ratio = 3:1
   Service factor = 1.25
   Material of pinion and gear = FG 200
   Design bending stress of material = 60 MPa
   Surface hardness of pinion and gear = 200 BHN
   Endurance strength of the material = 84 MPa
   Dynamic load factor = 178 N/mm
   Modulus of elasticity = 1.1 x 105 MPa
   Assume pitch line velocity as 7.5 m/sec for module calculation.

   \[ \text{Velocity factor}, \ C_v = \frac{3}{3 + v} \]
   \[ \text{Lewis form factor}, \ y = \left( \frac{0.154 - 0.912}{Z} \right) \text{ for } 20^\circ \text{ pressure angle full depth involute tooth system} \]
   \[ \text{Dynamic load equation}, \ F_d = F_t + \frac{21 \cdot v \cdot (f \cdot C + F_t)}{21 \cdot v + \sqrt{f \cdot C + F_t}} \]
   \[ \text{Wear load}, \ F_w = d_p \cdot f \cdot K \cdot W \cdot Q \]

Que: 5 Design a spur gear pair from the following given data.
   Power to be transmitted = 22.5 kW, Pinion speed = 1450 rpm, Speed reduction = 2.5, No. of teeth on pinion = 20, Service factor = 1.5, b = 10 mm, Pitch line velocity = 5 m/sec (For initial calculation of module), Maximum permissible error in gear tooth profile = 0.025 mm, k = A factor depending upon the form of teeth = 0.111, Velocity factor = 2 \left( \frac{3}{3 + V} \right), where V is the pitch line velocity in m/s.
   Take endurance surface hardness = 600 MPa
   Lewis form factor = 0.154 - 0.912/No. of teeth for 20° pressure angle involute tooth system.
   The materials and stresses are as under:

<table>
<thead>
<tr>
<th>Material</th>
<th>( \sigma_b )</th>
<th>Elasticity Modulus</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinion (Fe410)</td>
<td>135N/mm²</td>
<td>2.1*10^5 N/mm²</td>
<td>260 BHN</td>
</tr>
<tr>
<td>Gear (FG 200)</td>
<td>65N/mm²</td>
<td>1.1*10^5 N/mm²</td>
<td>250 BHN</td>
</tr>
</tbody>
</table>

Que: 6 A spur gear having 22 teeth to be made of plain carbon steel 40C8 (Sut=580N/mm²) is to be mesh with a gear having 88 teeth to be made of grey cast iron FG260 (Sut=260N/mm²). The pinion shaft is connected to 12KW, 1440 rpm electric motor. The starting torque of the motor is approximately twice the rated torque. The tooth system is 20° full depth involute. The face width is 10 times module for which the load distribution factor is 1.4. The gears are to be machined to meet the specifications of grade 7 for which deformation factor is 240 N/mm. (I) If factor of safety required against bending failure 1.0, design the gear pair by using velocity factor
   Velocity factor = and Buckingham’s equation for dynamic load. (II) If the factor of safety required against pitting failure is 1.5, specify surface hardness.
   Y = 0.484 - 2.87/z Buckingham’s equation \( F_d = F_t + \left\{ \frac{21v(bc+F_{max})/21v+(bc+F_{max})_0.5} \right\} \)
   K = 0.18(BHN/100); for steel pinion and cast iron Standard module are 4, 5, 6, 8, 10, 12, 16.
   Service factor =2, Load concentration factor=1.4
Chapter:-2 Helical Gear

Que:-1 A stock helical gear has normal pressure angle of 20\(^\circ\), a helix angle of 25\(^\circ\), and a transverse diametral pitch of 6 teeth / in, and has 18 teeth. find:
   a) The pitch diameter
   b) The transverse, the normal and axial pitches
   c) The normal diametral pitch
   d) The transverse pressure angle.

Que:-2 A helical gear speed reducer is to be designed. The rated power of the speed reducer is 75 k\(\text{w}\) at a pinion speed of 1200 rpm. The speed ratio is 3:1 for medium shock condition and 24 hr operation. Determine module, face width, no. of teeth in each gear. Specify material & heat treatment. The teeth are 20\(^\circ\) full depth in the normal plane.

Que:-3 The following data is given for a pair of helical gears made of steel: Normal module = 5 mm, Face Width = 50 mm, No. of Pinion Teeth = 30, No. of Gear Teeth = 60, Centre distance = 245 mm, Normal Pressure angle = 20\(^\circ\), Pinion speed = 1000 r.p.m, surface hardness = 300 BHN, FOS = 2, Service Factor = 1.5, Grade of Machining = 8, Tooth form factor (Y) = 0.385 Permissible \(\sigma\) for pinion and gear material=150N / mm\(^2\).
   Determine:(i) Helix angle (ii) Beam strength (iii) Max. static load that gear can transmit (iv) Power transmitting capacity

Que:-4 Design a gear pair of helical gear.

<table>
<thead>
<tr>
<th>Material</th>
<th>Gear</th>
<th>Pinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate Strength MPa</td>
<td>560</td>
<td>750</td>
</tr>
<tr>
<td>BHN</td>
<td>241</td>
<td>255</td>
</tr>
<tr>
<td>Pressure Angle in Degrees</td>
<td>20(^\circ)</td>
<td>20(^\circ)</td>
</tr>
<tr>
<td>Number of Teeth</td>
<td>70</td>
<td>35</td>
</tr>
<tr>
<td>Normal module in mm</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Face width in Normal module, mm</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Modulus Of Elasticity Gpa</td>
<td>205</td>
<td>200</td>
</tr>
</tbody>
</table>

Assume service factor 1.5 and factor of safety 3. Check wear and dynamic strength of gear. Helix angle is 25\(^\circ\).speed of pinion is 720 rpm.
Chapter: -3 Bevel Gear

Que: - 1 A pair of high grade cast iron bevel gears having shaft at right angle are to have an angular velocity ratio of driver to driven of 2 to 3. The driver is to rotate at 175 rev/min and is to transmit 10 KW. It is 0.4 meter in pitch diameter. Take the width of face as about one third of the length of pitch element and determine the pitch of the gear. Assume 24 hr/day operation.

Velocity factor = \( \frac{3}{3+v} \), Levis factor = \( \pi(0.154-0.921/\text{no. of teeth}) \)

Beam strength = \( \text{fef} \cdot m \cdot Y(1-F/L) \)

High grade cast iron \( \text{fef} = 84 \text{MPa} \), fes for cast iron = 630 MPa, \( \text{Ep} = \text{Eg} = 105 \text{MPa} \)

Que: - 2 A pair of straight bevel gears, manufactured by generation, consists of 14 teeth pinion meshing with 85 teeth gear. The module at large end is 5.5 mm while the face width is limited to 0.25 times the slant height. The pinion is made of steel having ultimate tensile strength is 750 N / mm² and surface hardness of 210 BHN. The gear is made of cast iron having ultimate tensile strength 260 N / mm² and surface hardness of 210 BHN. The shaft angle is 90°. If the pinion rotates at 750 rpm, estimate the power that gear pair can transmit.

Que: - 3 Two shafts at right to each other are connected by a bevel pair having full depth involute teeth. The pinion having 20 teeth transmits 40 kW at 750 rpm to gear shaft running at 375 rpm. Take allowable static stress for pinion and gear materials 100 N/mm² and 70 N/mm² respectively. Determine module, pitch diameters and face width.

Chapter: -4 Worm Gear

Que: - 1 Explain the importance of thermal considerations in worm and worm gear design.

Que: - 2 Why the efficiency of worm gear is low? Explain

Que: - 3 A speed reducer unit is to be designed for an input of 1.1 kW with transmission ratio 27. The speed of hardened steel worm is 1440 rpm. The worm wheel is to made from phosphor bronze. The tooth form is to be 200 involute. Take center distance between worm and worm wheel = x = 100 mm.

Pitch circle diameter of worm = \( \frac{x \cdot 0.876}{1.416} \), worm is double start.

\( \text{Cv} = \frac{6}{6+v} \)

Form factor \( y = 0.154 - 0.912/T \)

Allowable stress for phosphor bronze = 84 MPa, flexural endurance limit for phosphor bronze = 168 MPa, load stress factor = \( k = 0.55 \), check for:

1) Tangential load- power transmitted due to tangential load, 2) Dynamic load, 3) Static load or endurance strength, 4) Wear load, 5) Heat dissipation.

Que: - 4 A triple threaded worm rotating at 1200 r.p.m. drives a worm gear having 36 teeth and transmits 15 kW power. The teeth are of 20° full depth involute profile. The axial pitch of the worm is 30 mm and pitch diameter of 60 mm. The co-efficient of friction is 0.03. Calculate 1) Helix angle of worm 2) Speed ratio 3) Centre distance between two shafts, 4) Apparent stress in the worm gear. 5) Efficiency of drive.
Chapter: 5 Design of Multi Speed Gear Box

Que: 1 Explain design procedure for 6 speed reduction gear box.

Que: 2 Why it is necessary to provide multispeed drive for a machine tool? Give step by step procedure for the design of 8 speed drive for a lathe giving governing design equations.

Que: 3 Answer the following questions.
   (1) What are the basic considerations in design of multi speed gearbox?
   (2) Which conditions should be satisfied by optimum structure diagram of multi speed gear box?

Que: 4 Explain the procedure of designing multi speed gear box.

Que: 5 Design a suitable speed gear box for a head stock of a lathe that has a variation of speed from 105 r.p.m. to 690 r.p.m. in 9 steps. The power is supplied by an electric motor of 10 KW capacity running at 1000 r.p.m. and having driving the input shaft through a V-belt drive having speed ratio of 2:1. Draw the structural diagram, speed chart and determine the number of teeth on each gears.

Que: 6 A speed gearbox for a head stock of a lathe machine is to give speed variation from 125 rpm to 1500 rpm in 12 steps. The power is supplied to the input shaft by an electric motor of 5 kW running at 1500 rpm, through a belt drive, giving speed reduction 1.2:1. Find the speed steps arranged in geometric progression. Draw the structural diagram, Ray diagram and speed charts.

Que: 7 A three stage gear box with twelve speeds is to be designed based on R10 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 1440 rpm and transmits of 5 kW. Using standard spindle speeds,
   1. Draw the structure and speed diagram for the arrangement.
   2. Determine the ratio of the belt pulley diameters.
   3. Draw the gear box layout.
   4. Determine the number of teeth on each gear of the gear box.

Que: 8 A radial drill machine using a gear box is required to give 8 stepped speeds. The motor power is 4 kw at 1440 rpm. The power from motor to the input shaft of gear box is transmitted by a V belt drive giving a speed reduction of 1:6. The minimum and maximum speeds are 70 rpm and 1800 rpm respectively. Make layout diagram of gear box. Draw ray diagram and speed chart.

Chapter: 7 & 8 Design of Flywheel and Design of Material Handling Equipment

Que: 1 What are the basic objectives of a material handling system?

Que: 2 Answer the following questions.
   (i) What are the various factors to be consider for selecting material handling equipment’s for given application?
   (ii) Explain the concept of material handling system design.

Que: 3 Classify the material handling equipment’s.

Que: 4 A single cylinder double acting steam engine develops 150 kW at a mean speed of 80 r.p.m. The coefficient of fluctuation of energy is 0.1 and fluctuation of speed is -2% to +2% of mean speed. If the mean diameter of flywheel rim is 2 meters and the hub end spokes provides 5% of the rotational inertia of the wheel, find the mass of the flywheel and cross – sectional area of the rim. Assume the density of the CI flywheel as 7200 kg /m$^3$. 
Chapter:-9 Design of Rope Drive and Crank Hook

Que:-1 Explain Wire ropes with its designation. What are the advantages of wire ropes? Explain selection of wire ropes.

Que:-2 Select the ropes and drum for an overhead travelling crane with a lifting magnet.
Lifting capacity = 5000 kg (mass) Weight of lifting magnet = 200 kg (mass)
Weight of lifting tackle = 120 kg (mass)
Lifting height = 8 m No. of rope parts = 4

Que:-3 An elevator is designed to carry workers and materials to height of 40 meter. It is estimated that at least 10 workers with material load of 12 KN should be hoisted at a speed of 0.5m/sec which should be attained in the first 0.4s. The recommended steel wire rope is 6x19 with wire 10diameter 2.5mm. Determine factor of safety. Assume $E = 84\text{GPa}$, for $6\times19$ rope wire diameter $d_w=0.063d$, cross sectional area =0.38$d^2$, ultimate tensile strength for the wire rope is 435$d^2$

Que:-4 Explain design procedure of wire rope drum.

Que:-5 What do you understand by $6 \times 37$ ropes? Explain with neat sketch the different rope section.

Que:-6 Design a wire rope for a lift using following details:
  i. Number of ropes = 02
  ii. Maximum load on the ropes including the cabin weight = 8 kN
  iii. Tensile strength of $6\times19$ wire rope = 43.5 $d^2$ kN where $d =$ Rope diameter in cm.
  iv. Factor of safety = 12 and assume necessary data.

Que:-7 Find the main dimensions of a cast iron rope drum from the following data for winding rope (two sides):
  i. Maximum load to be lifted = 40 kN
  ii. Diameter of wire rope = 14 mm
  iii. Lifting height = 10 m iv. Number of falls = 04
  v. Drum diameter is 30 times rope diameter
  vi. Allowable stress for cast iron = 25 MPa
  vii. Use two movable sheaves.

Que:-8 Why trapezoidal section is used in hook? Draw net sketch of single hook and also mention its critical section.
Que: 9 Design the crane hook of a hoisting block for a maximum load lifting capacity of 10 tones (98.1 kN). The material for hook is forged steel for which permissible tensile stress may be taken as 120 N/mm². Choose most suitable cross section for the hook.

Que: 10 Explain design procedure designing belt conveyors.

Que: 11 The following data refers to a flat belt conveyor for transporting crushed rock, Mass density = 2 tons/m³, belt speed = 1.5 m/s, belt width (B) = 0.8 m, surcharge angle = 25°, effective width of the material carried by the belt safety = b = (0.9B - 0.05).

Que: 12 Explain classification and working of different types of conveyors.

Que: 13 Design a crane hook for lifting capacity of 5 tones. Take permissible tensile stress 80 N/mm² for forged steel. Assume a triangular section for hook design.

\[ R_n = \frac{(b_i + b_o)}{2} \cdot H - (b_i - b_o) \]

\[ R = R_i + \frac{H(2b_i + 2b_o)}{3(b_i + b_o)} \]

Que: 15 Determine the resistance offered by a single carrying and return idler for the conveyor having the following data:

Capacity of the conveyor is 400 tph, Belt speed is 2 m/s, Mass of belt = 16 kg/m, Mass of each idler = 25.1 kg, Carrying side pitch = 1 m, Return side pitch = 2 m, Coefficient of friction between the idler and the pulley = 0.02, Coefficient of friction between the roller pin and the idler = 0.04, Ratio of roller pin diameter to idler tube diameter = 0.5, Belt inclination = 15°.

Que: 16 An inclined conveyor handles an ore having a density of 1.5 t/m³. The material has to be conveyed over a distance of 2 kms and a height of 450 m. If the belt speed is to be 120 m/min, then determine the standard width of the four ply belt so that the material can be conveyed at a rate of 3 Tonnes/hr. For the inclined belt use the following data for the flow ability factor.

<table>
<thead>
<tr>
<th>Conveyor Inclination</th>
<th>Flowability Factor, C₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>10° - 15°</td>
<td>2.65 x 10⁻⁴</td>
</tr>
<tr>
<td>16° - 20°</td>
<td>2.50 x 10⁻⁴</td>
</tr>
<tr>
<td>21° - 25°</td>
<td>2.35 x 10⁻⁴</td>
</tr>
<tr>
<td>26° - 30°</td>
<td>2.20 x 10⁻⁴</td>
</tr>
<tr>
<td>31° - 35°</td>
<td>2.05 x 10⁻⁴</td>
</tr>
</tbody>
</table>

Standard belts widths are: 300, 400, 450, 500, 600, 650, 750, 800, 900, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400 mm.

Also determine the diameter and width of the drive pulley and the gear reduction ratio for the motor, if the motor speed is 1440 rpm. Assume the material for the ply of the belts has a material factor k₁ = 2.5 and the belt tension and arc of contact factor, k₂ = 80. The effective width b (in meter), of the material carried by the belt safety is given by the following equation: b = 0.9 B - 0.05, Where B = belt width in m.