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10AU63

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Design of Machine Elements – II

Time: 3 hrs.

Max. Marks:100

**Note: 1. Answer any FIVE full questions, selecting
atleast TWO questions from each part.
2. Missing data, if any, may be suitably assumed.
3. Use of data handbook is permitted.**

PART – A

1. a. The horizontal cross section of a crane hook is an isosceles triangle of 120 mm deep, the inner width being 90 mm. The hook carries a load of 50 kN. Inner radius of curvature is 100 mm. The load line passes through the centre line of curvature. Determine the stresses at the extreme fibres. (12 Marks)
b. Derive an expression for normal stresses due to bending at the extreme fibres on the cross section of a curved machine member. (08 Marks)
2. a. A cast iron thick cylinder of internal diameter 150 mm is subjected to an internal pressure of 12 N/mm². The allowable working stress for the cast iron may be taken as 20 N/mm². Determine
i) Thickness of cylinder wall.
ii) Thickness of the circular flat cylinder head cast integral with the cylinder walls. (06 Marks)
b. A cast iron cylindrical pipe of outside diameter 300 mm and inside diameter 200 mm is subject to an internal fluid pressure of 20 N/mm² and external fluid pressure of 5 N/mm². Determine the tangential and radial stresses at the inner, middle and outer surface. Also sketch the tangential stress and radial stress distribution across its thickness. (14 Marks)
3. a. Derive an expression for the deflection in a helical compression spring with usual notations. (08 Marks)
b. A railway wagon weighing 50 kN and moving with a speed of 8 km/hr has to be stopped by four buffer springs in which the maximum compression allowed is 220 mm. Find the number of turns or coils in which spring of mean diameter 150 mm. The diameter of spring wire is 25mm. Take $G = 84 \text{ GPa}$. Also find the shear stress. (12 Marks)
4. a. A cone clutch has a semi-cone angle of 12.5° to transmit 40 kW at 1000 rpm. The width of the face is one sixth of the mean diameter of friction lining. If the normal intensity of pressure between the contacting surface is not to exceed 0.2 N/mm². Assuming uniform wear criterion and taking $\mu = 0.4$. Calculate dimensions of clutch. Also find axial force while running i.e., at the beginning of engagement. (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any exceeding of identification number to evaluation and on questions written e.g. 12+8+50 will be treated as malpractice.

- b. A single block brake with drum diameter of 400 mm is shown in Fig.Q4(b). It rotates at a speed of 150 rpm. The friction material permits a maximum pressure of 0.5 MPa and $\mu = 0.25$. Face width of the block is 50 mm. Determine (i) Effort (ii) Maximum Torque (iii) Heat generated. (10 Marks)

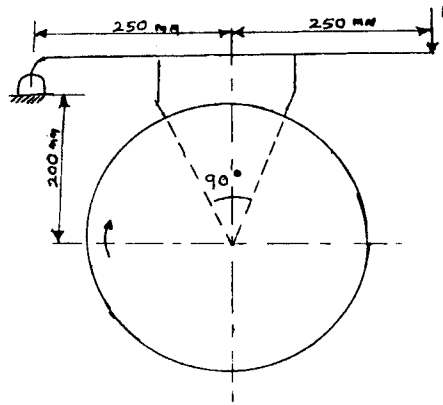


Fig.Q4(b)

PART – B

- 5 A pair of carefully cut spur gears with 20° full depth involute profile is used to transmit 12 kW at 1200 revolutions per minute of pinion. The gear has to rotate at 300 revolutions per minute. The material used for both pinion and gear is medium carbon steel whose allowable bending stress may be taken as 230 MPa. Determine the module and facewidth. Also suggest suitable surface hardness. Take 24 teeth on pinion. Modulus of elasticity may be taken as 210 GPa. (20 Marks)
- 6 Design a worm gear drive to transmit a power of 2 kW at 1000 rpm. The speed ratio is 20 and the centre distance is 200 mm. Assume hardened steel worm and phosphor bronze ($\sigma_{o2} = 55 \text{ N/mm}^2$) worm wheel. Approximate $y = 0.154 - \frac{0.912}{z}$. (20 Marks)
- 7 a. Derive Petroff's equation for coefficient of friction in journal bearings. (08 Marks)
 b. A 75 mm long full journal bearing of diameter 75 mm supports a radial load of 12 kN at the shaft speed of 1800 rev/min. Assume ratio of diameter to the diametral clearance as 1000. The viscosity of oil is 0.01 Pas at the operating temperature. Determine the following :
 (i) Sommerfeld number.
 (ii) The coefficient of friction based on McKee equation.
 (iii) Amount of heat generated. (08 Marks)
 c. Explain Hydrodynamic theory of lubrication. (04 Marks)
- 8 a. A 20 mm 8×19 steel wire rope is used with a hoisting drum of 1 m diameter to lift a load of 20 kN. The depth of mine is 800 m and the acceleration is 3 m/sec^2 . Determine the number of ropes required using a factor of safety 5. Neglect the weight of skip. Take modulus of elasticity of rope = 82728.5 MPa. (10 Marks)
 b. A belt of 100 mm wide and 10 mm thick is transmitting power at 1000 m/min. The net driving tension is 2 times the slack side tension. Allowable stress in the material is 2 MPa. Specific weight of the belt material is 10 kN/m^3 . Determine the power that can be transmitted by the belt. Also determine the absolute power that can be transmitted by the belt and the velocity at which that power can be transmitted. (10 Marks)

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10AU63

Sixth Semester B.E. Degree Examination, June/July 2016
Design of Machine Elements – II

Time: 3 hrs.

Max. Marks: 100

**Note: 1. Answer any FIVE full questions, selecting
 atleast TWO questions from each part.
 2. Use design data hand book is allowed.**

PART – A

- 1 a. List out the differences between the straight and curved beam and also sketch the stress distribution pattern in the curved beams and compare it with the straight beams. **(05 Marks)**
- b. Compute the combined stresses at the inner and outer fibers in the critical cross section of a crane hook which is required to lift load upto 25 kN. The hook has trapezoidal cross section with parallel sides 60 mm and 30 mm, the distance between them being 90 mm. The inner radius of the hook is 100 mm. The load line is nearer to the inner surface of the hook by 25 mm than the centre of curvature at the critical section. **(15 Marks)**

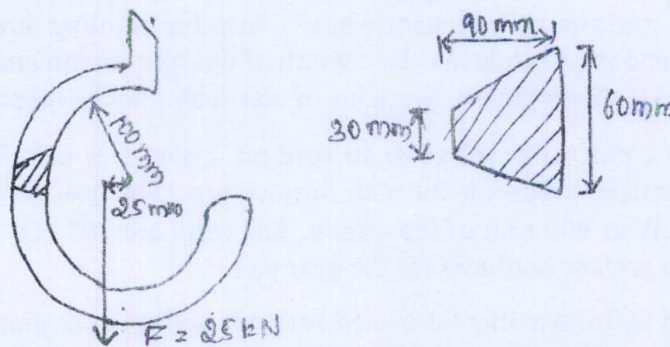


Fig. Q1(b)

- 2 a. A cast iron cylindrical pipe of outer diameter 300 mm and inside diameter 200 mm subjected to an internal pressure of 20 N/mm² and external fluid pressure is 5 N/mm². Determine the tangential and radial stresses at the inner, middle and outer surface. Also sketch the tangential and radial stresses distribution across its thickness. **(10 Marks)**
- b. A shrink fit assembly formed by shrinking one cylinder over another is subjected to an internal fluid pressure of 60 N/mm². Before the fluid is admitted, the internal and external diameters of the assembly are 120 mm and 200 mm respectively and diameter at the junction is 160 mm. If after shrinking, the contact pressure at the junction is 8 N/mm², determine using Lamé's equations, the tangential stresses at inner, mating and outer surfaces of the assembly after the fluid has been admitted. **(10 Marks)**
- 3 a. Derive an expression for the stress induced in a helical spring, with usual notation. **(06 Marks)**
- b. Design a spring for an elevator shaft at the bottom of which 8 identical springs are set in parallel to absorb the shock of the elevator incase of failure. Weight of the elevator is 60 kN and counter weight of elevator is 20 kN. Elevator has a free fall of 1.5 m from rest. The spring is made of 25 mm diameter rod. Determine the maximum stress in each spring if the spring index is 6. Each spring has 15 active turns. Take $G = 84 \text{ GPa}$. **(14 Marks)**

- 4 a. A plate clutch of maximum diameter 600 mm has max lining pressure of 0.35 MPa. The power to be transmitted at 400 rpm is 135 KW and $\mu = 0.3$. Find the inside diameter and spring force required to engage the clutch. If the springs with spring index 6 and the material of the spring is steel with safe shear stress 600 MPa is used. Find the wire diameter if 6 springs are used. (10 Marks)
- b. A single block brake with a torque capacity of 15 Nm is shown in Fig. Q4(b). The coefficient of friction is 0.3 and the maximum pressure on the brake lining is 1 N/mm^2 . The width of the block is equal to its length. Calculate :
i) Actuating force ii) resultant hinge-pin reaction iii) dimensions of block iv) rate of heat generated if brake drum rotates at 50 rpm. (10 Marks)

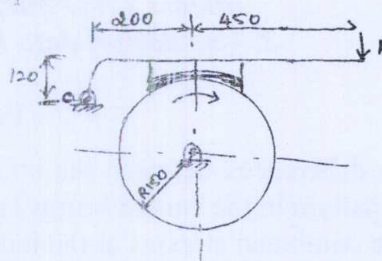


Fig. Q4(b)

PART - B

- 5 a. Explain formative number of teeth in helical gears. (04 Marks)
- b. A pair of carefully cut spur gears with 20° FD involute profile is used to transmit 12 KW at 1200 rpm of pinion. The gear has to rotate at 300 rpm. The material used for both pinion and gear is medium carbon steel whose allowable bending stresses may be taken as 230 MPa. Determine the module and face width of the spur pinion and gear. Suggest suitable hardness. Take 24 teeth on pinion. Modulus of elasticity may be taken as 210 GPa. (16 Marks)
- 6 Design a pair of bevel gears to connect 2 shafts at 60° . The gears are alloy steel of case hardened and precision cut with form cutters. The gear ratio is 5 : 1. The power transmitted is 30 KW at 900 rpm of the pinion. The teeth are 20° FD. The pinion has 24 teeth. Suggest suitable surface hardness for the gear pair. (20 Marks)
- 7 a. Explain hydrodynamic lubricated bearings and squeeze journal bearing. (04 Marks)
- b. 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 rpm and the ratio of journal diameter to the diameter 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/ms . The room temperature is 35°C . Find : i) The amount of artificial cooling required
ii) The mass of lubricating oil required if the difference between the outlet and inlet temperature of the oil is 10°C . Take specific heat of oil as $1850\text{ J/kg}^\circ\text{C}$. (06 Marks)
- c. Design a journal bearing for a centrifugal pump from the following data. Load on journal = 20000 N, speed and journal = 900 rpm, type of oil is SAE 10 for which the absolute viscosity at $55^\circ\text{C} = 0.017\text{ kg/m sec}$. Ambient temperature for oil is 15.5°C , the maximum bearing pressure of the pump = 1.5 N/mm^2 . (10 Marks)
- 8 a. A V-belt is to transmit 20 KW from a 250 mm pitch diameter sheave operating at 1500 rpm to a 900 mm diameter flat pulley. The centre distance between input and output shafts is 1 m. The groove angle is 40° and coefficient of friction is 0.2 for both pulley and sheaves combinations. The cross section of the belt is 38 mm wide at the top and 19 mm wide at the bottom by 25 mm deep. Each belt weights 11 kNm^3 and allowable tension per belt is 1000 N. How many belts are required? (10 Marks)
- b. Select a 6×19 steel rope to lift 15 kN of debris from a tunnel of 200 m deep. The bucket weights 8 kN. The velocity of the rope is 100m/min to be attained in 20 secs. What will be the max load on the rope when there is a slack of 10 m in the rope? (10 Marks)

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Sixth Semester B.E. Degree Examination, Dec.2015/Jan.2016

Time: 3 hrs.

Max. Marks:100

Note: 1. Answer FIVE full questions, selecting at least TWO questions from each part.
2. Assume suitable data if missing.
3. Design data hand book is permitted.

1 a. Derive an expression for normal stresses due to bending at the extreme fibers on the cross section of a curved beam member. (06 Marks)

b. Determine the safe load F that the frame of a punch press as shown in figure Q1 (b) can carry considering the cross section along A – A for an allowable tensile stress of 100MPa. What is the stress at the outer fiber for the above load? What will be the stress at the inner fiber, if the beam is treated as the straight beam for the above load? (14 Marks)

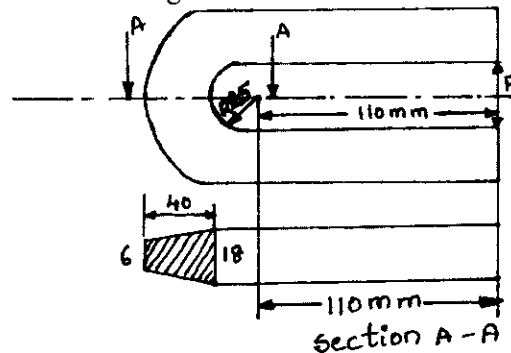


Fig. Q1 (b)

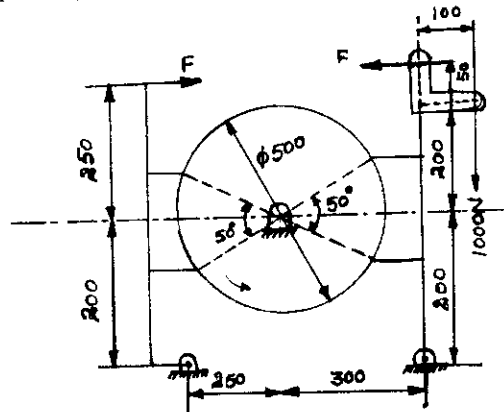
- 2 a. A hydraulic cylinder 400mm bore operates at a maximum pressure of 5N/mm^2 . The piston rod is connected to the load and the cylinder to the frame through hinged joints. Design (1) cylinder, (2) piston rod (3) Hinge pin and (4) Flat end cover. The allowable tensile stress for cast steel cylinder and end cover is 80MPa and for pinion rod is 60MPa.
(10 Marks)
- b. A shrink fit assembly, formed by shrinking one tube over another, is subjected to an internal pressure of 60MPa. Before the fluid is admitted, the internal and external diameters of the assembly are 120mm and 200mm and the diameter at the junction is 160mm. If after shrinking on, the contact pressure at the junction is 8MPa, determine using Lamé's equations, the stresses at the inner mating and outer surfaces of the assembly after the fluid has been admitted.
(10 Marks)
- 3 a. Derive an expression for shearing stress induced in a helical spring subjected to a compressive load, P with suitable stress diagrams.
(06 Marks)
- b. A semi – elliptical laminated vehicle spring to carry a load of 6000N is to consist of seven leaves 65mm wide, two of the leaves extending the full length of the spring. The spring is to be 1.1m in length and attached to the axle by two U – bolts 80mm apart. The bolts hold the central portion of the spring so rigidly that they may be considered equivalent to a band having a width equal to the distance between the bolts. Assume design stress for spring material as 350MPa. Determine i) Thickness of leaves ii) Deflection of spring
iii) Diameter of eye iv) Length of leaves and v) Radius of which leaves should be initially bent. Take $E = 210 \times 10^3 \text{ N/mm}^2$.
(14 Marks)

Important Note :

1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg. $42+8=50$, will be treated as malpractice.

- 4 a. A cone clutch has a semi cone angle of 12° to transmit 10kW at 750rpm. The width of the face is one fourth of the mean diameter of friction lining. If the normal intensity of pressure between the contacting surface is not to exceed 0.85 bar, assuming uniform wear criterion and taking $\mu = 0.2$. Calculate dimensions of clutch. Also find the axial force while running i.e., at the beginning of engagement. (08 Marks)
- b. A double block brake is shown in Fig Q4 (b). the drum rotates at 200rpm when the applied force is 1000N and $\mu = 0.25$. Determine i) Braking torque ii) Power lost as heat iii) Amount of heat generated.

Fig. Q4(b)



(12 Marks)

PART – B

- 5 Design a pair of helical gears for transmitting 22kW. The speed of driver gear is 600rpm. The helix angle is 30° and profile is corresponding to 20° full depth system. The driver gear has 24 teeth. Both the gears are made of cast steel with allowable static stress as 50MPa. Assume face width parallel to the axis as 4 times the circular pitch and the overhang for each gear as 150mm. The allowable shear stress for the shaft material may be taken as 50MPa. The form factor may be taken as $0.154 - \frac{0.912}{T_E}$ where T_E is the equivalent number of teeth. The velocity factor may taken as $\frac{350}{(350 + V)}$, where V is pitch line velocity in m/min. the gears are required to be designed only against bending failure of the teeth under dynamic conditions. (20 Marks)

- 6 A pair of bevel gears connects two shafts at right angles and transmits 9kW. Determine the required module and gear diameters for the following specifications.

Particulars	Pinion	Gear
Number of teeth	21	60
material	Semi-Steel	Frey Cast Iron
Allowable static stress	85 MPa	55MPa
Speed	1200rpm	420rpm
Tooth profile	$14\frac{1}{2}^\circ$ composite	$14\frac{1}{2}^\circ$ composite
Young's Modulus	$210 \times 10^3 \text{ N/mm}^2$	$84 \times 10^3 \text{ N/mm}^2$

Assume load stress factor as 0.107 N/mm^2 , flexural endurance limit as 84MPa and surface endurance limit as 630MPa. Check the gears – for dynamic and wear loads. (20 Marks)



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- 7 a. Derive Petroff's equation for coefficient of friction for Hydrodynamic bearing with simple diagram and mention the assumptions. (05 Marks)
- b. Design a Journal bearing for centrifugal pump running at 1200rpm. Diameter of Journal is 100mm and load on bearing is 15kN. Take $\frac{L}{d} = 1.5$, bearing temperature 50°C and ambient temperature 30°. Find whether artificial cooling is required? (15 Marks)
- 8 a. Design a suitable cross – belt drive, for a flat belt the following data is given
 Speed of motor = 1500rpm
 Speed of driven pulley = 300rpm
 Power to be transmitted = 10kW
 Weight density of leather = 10×10^{-6} N/mm³
 Smaller pulley diameter to thickness of belt ratio = 20
 Centre distance = 3m
 Allowable stress in the belt = 2.5MPa
 Velocity of belt drive = 15m/sec
 Load factor = 1.2
 Coefficient of friction = 0.3. (10 Marks)
- b. Select a wire rope to lift a load of 10kN through a height of 600m from a mine. The weight of bucket is 2.5kN. The load should attain a maximum speed of 50m/min is 2 seconds. (10 Marks)

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Sixth Semester B.E. Degree Examination, June/July 2015

Design of Machines Elements – II

Time: 3 hrs.

Max. Marks:100

- Note:** 1. Answer any FIVE full questions, selecting atleast TWO questions from each part.
2. Use of design data handbook is permitted.
3. Assume suitable data if missing.

PART – A

- 1 a. Write the difference between straight beam and curved beam. (04 Marks)
b. Compute the combined stresses at the inner and outer fibres in the critical cross section of a crane hook which is required to lift loads up to 25kN. The hook has trapezoidal cross-section with parallel sides 60mm and 30mm, the distance between them being 90mm. The inner radius of the hook is 100mm. The load line is nearer to the inner surface of the hook by 25mm than the centre of curvature at the critical section. What will be the stresses at the inner and outer fibre, if the beam is treated as straight beam for the given load? (16 Marks)
- 2 a. A 400mm outside diameter \times 200mm inside diameter steel hub is to have a shrink fit on a shaft of diameter 200mm. The tangential stress is to be limited to 90MPa. The hub length is 270mm. Modulus of elasticity is 206 GPa. Poisson ratio is 0.3.
i) Find and sketch the resulting stress distribution.
ii) The original diameter before shrink fit.
iii) The axial force necessary to assemble the hub taking coefficient of friction as 0.1.
iv) The power that can be transmitted by this joint at 1200rpm. (14 Marks)
b. The cylinder of a hydraulic press is 100mm inside diameter with wall thickness of 16mm. If the allowable stress in the steel used is 150MPa, find the safe force that can be withstood by this cylinder. (06 Marks)
- 3 a. Design a valve spring for an automobile engine, when the valve is closed, the spring produces a force of 45N and when it opens, produces a force of 55N. The spring must fit over the valve bush which has an outside diameter of 20mm and must go inside a space of 35mm. The lift of the valve is 6mm. The spring index is 12. The allowable stress may be taken as 0.33 GPa. Modulus of rigidity 80 GPa. (10 Marks)
b. Design a leaf spring for the following specifications for a truck. Total load = 120kN. Number of springs = 4. Material for the spring is chrome-vanadium steel, permissible stress is 0.55 GPa. Span of spring = 1100mm. Width of central band = 100mm and allowable deflection = 80mm. Number of full length leaves are 2 and graduated leaves 6. (10 Marks)
- 4 a. A cone clutch has a semi-cone angle of 12° to transmit 10 kW at 750 rpm. The width of the face is one fourth of the mean diameter of friction lining. If the normal intensity of pressure between the contacting surface is not to exceed 0.85 bar, assuming uniform wear criterion and taking $\mu = 0.2$. Calculate dimensions of clutch. Also find the axial force while running i.e. at the beginning of engagement. (10 Marks)

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- b. A single band brake operates on a drum 600mm in diameter that is running at 200 rpm while absorbing 15 kW of power. The coefficient of friction is 0.25. The brake band has a contact of 270° and one end is fastened to a fixed pin and the other end to the brake arm 125mm from the fixed pin. The straight brake arm is 750mm long and is placed perpendicular to the diameter that bisects the angle of contact. Determine:
- The maximum effort required to stop the rotation of drum.
 - Width of 2.5mm thick steel band, if the maximum tensile stress in it is not to exceed 56 MPa.

(10 Marks)**PART – B**

- 5 A pair of carefully cut spur gears transmit 20 kW from a shaft rotating at 1000 rpm to a parallel shaft which is to rotate at 310 rpm. Assume number of teeth on pinion 31 and 20° full depth tooth form. The material for pinion is C40 steel untreated and for gear cast steel 0.20% C untreated. Take service factor 1.5. Design the gear against dynamic load and wear load. **(20 Marks)**
- 6 A pair of bevel gear wheels with 20° pressure angle consist of 20 teeth pinion meshing with 30 teeth gear. The module is 4mm while the face width is 20mm. The surface hardness of both pinion and gear is 40 BHN. The pinion rotates at 500rpm and receives power from an electric motor. The starting torque of the motor is 150% of the rated torque. Determine the safe power that can be transmitted considering the dynamic load, wear strength. The allowable bending stress may be taken as 240 MPa. **(20 Marks)**
- 7 a. A 75mm long full journal bearing of diameter 75mm supports a radial load of 12kN at the shaft speed of 1800 rpm. Assume ratio of diameter to the diametral clearance as 1000. The viscosity of oil is 0.01 Pas at the operating temperature. Determine the following:
- Sommerfeld number
 - The coefficient of friction based on McKee equation
 - Amount of heat generated.
- (10 Marks)**
- b. List the advantages and disadvantages of rolling bearings compared to journal bearings. **(05 Marks)**
- c. A single row deep groove ball bearing has a specific dynamic capacity of 46.3 kN. The actual radial load = 9kN. The speed of rotation is 1800 rpm. What is the life in
- Cycles of operation
 - in hours
 - What is average life?
- (05 Marks)**
- 8 a. A nylon core flat belt 200mm wide weighing 20 N/m, connecting a 300mm diameter pulley to a 900mm diameter driven pulley at a shaft. Spacing of 6m transmits 55.2 kW at a belt speed of 25m/s.
- Calculate the belt length and the angle of wrap.
 - Calculate belt tensions based on a coefficient of friction 0.38.
- (08 Marks)**
- b. Select a V-belt drive to transmit 10 kW of power from a pulley of 200mm diameter mounted on an electric motor running at 720 rpm to another pulley mounted on compressor running at 200 rpm. The service is heavy duty varying from 10 hrs. to 14 hours per day and centre distance between centre of pulleys is 600mm. **(12 Marks)**
