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10ME52

Fifth Semester B.E. Degree Examination, Aug./Sept.2020
Design of Machine Elements – I

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Use of Data handbook is permitted.

PART – A

1 a. Write notes on :
(i) Ferrous materials and their properties
(ii) Codes and Standard **(08 Marks)**

b. A point in a structural member subjected to plane stress is shown in Fig.Q1(b). Determine the following :
(i) Normal and tangential stress intensities on plane MN inclined at 30°.
(ii) Principal stresses and their directions.
(iii) Maximum shear stress and the direction of the planes on which then occur.

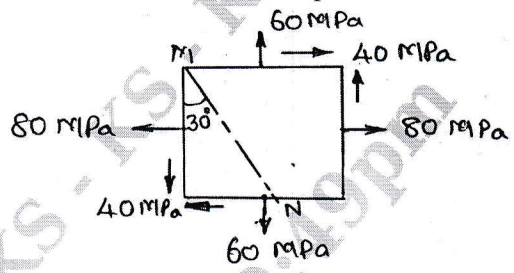

Fig.Q1(b) **(12 Marks)**

2 a. A steel shaft is subjected to a bending moment of 10 kNm and a twisting moment of 15 kNm. The yield stress of steel is 360 MPa and Poisson's ratio is 0.3. The factor of safety is 2. Determine the permissible diameter of the shaft according to (i) Maximum shear stress theory, (ii) Maximum normal stress theory, (iii) Maximum strain theory, (iv) Maximum distortion theory. **(10 Marks)**

b. A sliding weight 1 kN falls onto a flange at the end of a vertical circular rod of length 3 m. The diameter of the rod is 22 mm. Assuming no loss of energy, determine the height through which the weight should drop in order to produce a stress in the rod of 150 MPa. Also find the elongation of the rod due to impact. Take E = 190 GPa. **(10 Marks)**

3 A hot rolled steel shaft is subjected to a torsional moment that varies from 400 Nm clockwise to 200 Nm counter clockwise as the bending moment at the critical section varies from 400 Nm to – 200 Nm. Determine the diameter of the shaft for infinite life using factor of safety 2. The material has an ultimate strength of 550 MPa, yield strength of 440 MPa and the endurance limit of 275 MPa. Take the shear yield strength as $0.5\sigma_y$ and the shear endurance limit as $0.29\sigma_u$. The fatigue stress concentration factor for bending and torsion may be taken as 1.5 and 1.3 respectively. **(20 Marks)**

4 a. A bolted joint is used to connect two components. The combined stiffness of the two components is twice the stiffness of the bolt. The initial lightening load on the bolt is 10 kN. The bolt is further subjected to an external force of 20 kN. Determine the size of the bolt if the allowable stress in the bolt is limited to 120 MPa. **(08 Marks)**

b. A bracket is bolted to a vertical support by seven bolts of equal size as shown in Fig.Q4(b). Determine the size of the bolt, if the allowable shear stress in the bolt material is 40 MPa.

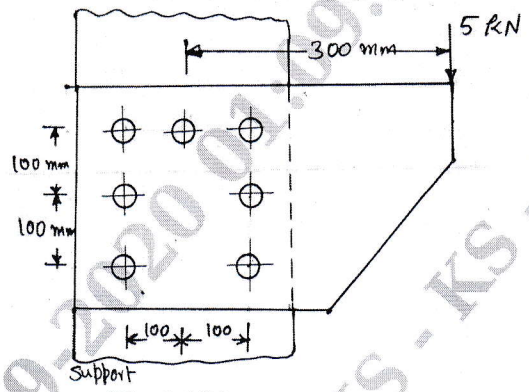

Fig.Q4(b) **(12 Marks)**

PART – B

5 A commercial steel shaft is supported on bearings 1m between centers. A cast iron pulley of 0.6m diameter weighing 1 kN is located 0.3m to the right of the right hand bearing and receives 25 kW power at 1000 rpm from a motor pulley by horizontal belt drive directly behind it. The ratio of belt tensions is 3. A 20° spur pinion of pitch circle diameter 0.2m weighing 200 N is located 0.2m to the left of the left bearing. The pinion delivers power to another gear mounted directly behind it such that the tangential force on the pinion acts vertically upwards. Assume minor shock loads on the shaft, determine the necessary diameter of the shaft if the allowable shear stress is limited to 60 MPa. **(20 Marks)**

6 a. Design a cotter joint to resist a load of 50 kN, which acts along the axes of the rods connected by a cotter. The material of the rod and cotter is the same. Take the working stresses in the material as 100 MPa in tension, 50 MPa in shear and 150 MPa in crushing. **(10 Marks)**

b. Design a protective type cast iron flange coupling for steel shaft transmitting 40 kW power at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The allowable shear stress in the steel bolt and cast iron flanges are 60 MPa and 10 MPa respectively. **(10 Marks)**

7 a. Design a triple riveted butt joint with double straps of equal width longitudinal butt joint for the boiler shell of 1.5 m diameter. The maximum steam pressure is 2.6 N/mm^2. The allowable stresses in tension, shear and crushing are 124 N/mm^2, 93 N/mm^2 and 165 N/mm^2 respectively. The pitch in the outer rows in each plate is twice the pitch of rivets in the inner row. Assume that the rivets in double shear are 1.875 times stronger than in single shear and the joint efficiency as 80%. **(10 Marks)**

b. A steel plate of 10mm thick is welded to a vertical support using four sides 6mm fillet welds as shown in Fig.Q7(b). Find the safe load P if the permissible shear stress in the weld is 75 N/mm^2.

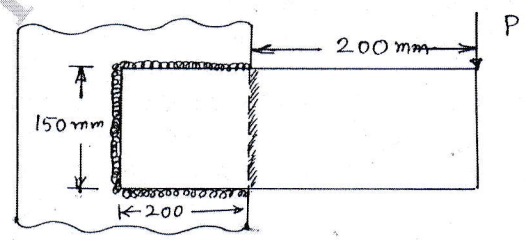

Fig.Q7(b) **(10 Marks)**

8 a. Explain self locking screw. **(04 Marks)**

b. A machine slide weighing 12 kN is raised by a single start square treaded steel screw. The allowable stress in the material is 72.5 MPa. The mean diameter of the collar is 40mm. The nut is made of phosphor bronze having design stress of 45 MPa. The bearing pressure between the screw and the nut is 9 MPa. Determine the dimensions of screw and nut and the power required to raise the slide. The maximum speed of the slide is 0.4 m/min. **(16 Marks)**

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10ME54

Fifth Semester B.E. Degree Examination, Aug./Sept.2020

Dynamics of Machines

Time: 3 hrs. Max. Marks:100

Note: Answer any FIVE full questions, selecting at least TWO questions from each part.

PART – A

1 a. What is "principal of virtual work"? Explain. **(05 Marks)**

b. In a four bar mechanism shown in Fig.Q1(b), torque T_3 and T_4 have magnitudes of 3000 Nm and 2000 Nm respectively. Take AD = 800 mm, AB = 300 mm, BC = 700 mm and CD = 400 mm. For static equilibrium of mechanism, find the required input torque on the crank.

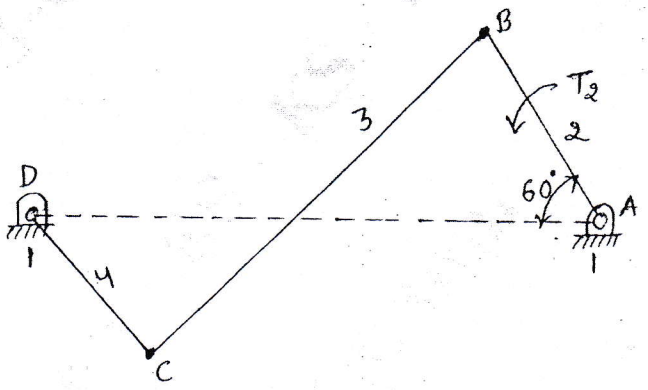

Fig.Q1(b) **(15 Marks)**

2 a. Explain D'Alembert's principle and why it is used. **(05 Marks)**

b. A single cylinder, four stroke I.C. engine develops 30 KW of power at 300 rpm. The T.M. diagram for the expansion and compression strokes may be taken as isosceles triangles on bases 0 to π and 3π to 4π radians respectively and the work done during compression is 25% of that of during expansion. Work done during suction and exhaust is neglected. Find the M.I. of flywheel to keep the speed fluctuation 1.5% on either side of mean speed. Sketch the T.M. diagram and mark on the diagram the points of maximum and minimum speed. **(15 Marks)**

3 a. Derive an expression for frictional torque in a flat collar bearing assuming uniform pressure and uniform wear. **(08 Marks)**

b. A flat belt is required to transmit 35 KW from a pulley of 1.5m effective diameter running at 300 rpm. The angle of contact is spread over $\frac{11}{24}$ of the circumference and the coefficient of friction between the belt and the pulley surface is 0.3. Determine taking centrifugal force into account width of belt required, it is given that the belt thickness is 9.5 mm, density of material is 1.1 mg/m^3 and the permissible working stress is 2.5 MPa. **(12 Marks)**

4 a. Why is balancing of rotating parts necessary for high speed engines? **(04 Marks)**

b. Four masses of magnitude 5, 6, M and 8 kg revolve in planes A, B, C and D respectively. The planes B, C, D are placed at a distance 0.3m, 1.2m and 2.0m respectively from A. The masses are at same radii of 0.3m. Find the magnitude of M and relative angular position of all masses for complete balance. **(16 Marks)**

PART – B

5 a. What are in-line engines and state how are they balanced? **(05 Marks)**

b. In a 3 cylinder radial engine all the connecting rods acts on a single crank. The cylinder centre lines are set at 120°. Mass of reciprocating parts per cylinder = 2.5 kg. Crank length = 0.075 m, connecting rod length = 0.275 m and speed = 1800 rpm. Determine:

(i) Maximum unbalanced primary force and the balancing mass to be attached at 100 mm radius to give primary balance

(ii) Maximum unbalanced secondary force and the balancing mass to be attached at 100 mm radius to give secondary balance. **(15 Marks)**

6 a. Define the following:

(i) Controlling Ffrce (ii) Isochronous Governor

(iii) Stability (iv) Hunting **(04 Marks)**

b. In a Hartnell governor the length of ball and sleeve arm are 12 and 10 cm respectively. The distance at fulcrum of the bell crank lever from the governor axis is 14 cm. Mass at each governor ball is 4 kg. When the governor runs at the mean speed of 300 rpm, the ball arm is vertical and sleeve arm is horizontal. For an increase of speed of 4% the sleeve moves 10 mm upward. Neglecting friction find:

(i) Minimum equilibrium speed if total sleeve movement is 20 mm

(ii) Spring stiffness

(iii) Sensitiveness of governor

(iv) Spring stiffness if governor is to be isochronous at 300 rpm. **(16 Marks)**

7 a. Derive an expression for the gyroscopic couple. **(05 Marks)**

b. The rotor of the turbine of a ship has a mass of 2500 kg and rotates at a speed of 3200 rpm counter clockwise when viewed from stern. The rotor has radius of gyration of 0.4 m. Determine the gyroscopic couple and its effect when,

(i) The ship steers to the left in a curve of 80 m at a speed of 27,900 m/hr

(ii) The ship pitches 5° above and 5° below the normal position and the bow is descending with its maximum velocity. The pitching motion is simple harmonic with a periodic time of 40 seconds.

(iii) The ship rolls and at the instant the angular velocity is 0.04 rad/sec clockwise when viewed from stern. **(15 Marks)**

8 A flat ended valve tappet is operated by a symmetrical cam with circular arcs for flank and nose profiles. The total angle of action is 150°, base circle diameter 125 mm and the lift 25 mm. During the lift, the period of acceleration is half that of the deceleration. Speed of the cam shaft is 1250 rpm. The straight line path of the tappet passes through the cam axis. Find:

(i) Radii of the nose and the flank

(ii) Maximum acceleration and deceleration during the lift **(20 Marks)**

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10ME56

Fifth Semester B.E. Degree Examination, Aug./Sept.2020

Turbo Machines

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of thermodynamic data hand book is permitted.***

PART – A

1 a. Differentiate between a turbomachines and positive displacement machines. **(04 Marks)**

b. Define specific speed of a turbine. Derive an expression for specific speed of a turbine from fundamentals. **(06 Marks)**

c. Tests on a turbine runner 1.25 m in diameter at 30 m head gave the following results:
(i) Power developed = 736 KWatts
(ii) Speed = 180 rpm
(iii) Discharge = 2.70 m^3/sec
Find the diameter, speed and discharge of runner to operate at 45 m head and give 1472KWatts at the same efficiency. What is the specific speed of the both the turbines? **(10 Marks)**

2 a. Define:
(i) Total-to-total efficiency
(ii) Total static efficiency for power absorbing turbomachines with H-S diagram **(06 Marks)**

b. Show that Reheat Factor in multi stage turbine is greater than unity along with H-S diagram. **(06 Marks)**

c. A gas turbine has the following data. Inlet pressure and temperature 5 bar and 500K, exit pressure is 1.2 bar overall turbine efficiency is 0.90. Mass flow rate of the gas is 20 kg/sec. Determine the polytropic efficiency of expansion. Take C_p = 1.005 kJ/kgK and r = 1.4. **(08 Marks)**

3 a. Define Degree of Reaction. Explain the components of degree of reaction. **(05 Marks)**

b. Obtain the expression for maximum utilization factor in 50% reaction turbine. **(07 Marks)**

c. At a 50% reaction stage axial flow, turbine, the mean blade diameter is 60 cm. The maximum utilization factor is 0.9. Steam flow rate is 10 kg/sec. Calculate the inlet and outlet velocities and power developed if the speed is 2000 rpm. **(08 Marks)**

4 a. Sketch and explain radial flow turbomachine with inlet and outlet velocity triangles and show that the degree of reaction $R = \frac{2 + \cos\beta^2}{4}$. **(10 Marks)**

b. A turbine with 50% reaction the tangential blade speed is 98.5 m/sec. The steam velocity at the nozzle exit is 155 m/sec and the nozzle angle is 18°. Assuming symmetric inlet and outlet velocity triangles. Compute the inlet blade angle for the rotor and the power developed by the stage for a flow rate of 10 kg/sec. Also find the utilization factor. **(10 Marks)**

PART – B

5 a. What is compounding? Explain briefly a two-stage pressure compounding impulse turbine and show the velocity and pressure variations across the turbine. **(10 Marks)**

b. In a stage impulse turbine, the steam velocity at nozzle mouth is 300 m/sec. The nozzle angle 18° and blade velocity is 144 m/sec. Draw to a suitable scale the diagram of relative velocities for the steam assuming that the outlet blade angle is 3° less than inlet angle. Take blade velocity coefficient as 0.86. If the power to be developed is 1000 KWatts. Calculate the mass of steam that passes through the turbine/sec. **(10 Marks)**

6 a. Derive an equation for maximum efficiency condition of impulse type hydraulic turbine $\eta_{max} = \frac{1+\cos\beta_2}{2}$. **(10 Marks)**

b. A Kaplan turbine working under a head of 15 m develops 7350 KW power. The outer diameter of runner is 4m and hub diameter is 2m. The guide blade angle at the extreme edge of the runner is 30°. The hydraulic and overall efficiency of the turbine are 90% and 85% respectively. If the velocity of whirl is zero at outlet, determine:

(i) Runner vane angle at inlet and outlet at the extreme edge of the runner

(ii) Speed of the turbine **(10 Marks)**

7 a. Define the following terms for a centrifugal pumps:

(i) Net positive suction head

(ii) Manometric efficiency

(iii) Mechanical efficiency **(06 Marks)**

b. Derive an expression for a minimum starting speed for a centrifugal pump. **(06 Marks)**

c. The outer diameter of the impeller of a centrifugal pump is 40 cm and the width of the impeller at outlet is 5 cm. The pump is running at 800 rpm and working against a total head of 15 m. The vane angle at outlet is 40° and manometric efficiency is 75%. Determine:

(i) Velocity of flow at outlet

(ii) Velocity of water leaving the vane

(iii) Angle made by the absolute velocity at outlet

(iv) Discharge of pump **(08 Marks)**

8 a. What is the function of diffuser? Name different types of diffusers used in centrifugal compressor and explain them with simple sketches. **(10 Marks)**

b. Air enters a compressor at a static pressure of 1.5 bar, a static temperature of 15°C and a flow velocity of 15 m/sec. At the exit the static pressure is 3 bar. The static temperature is 100°C and the flow velocity is 100 m/sec. The outlet is 1m above the inlet. Evaluate:

(i) The isentropic change of enthalpy

(ii) The actual change in enthalpy

(iii) Efficiency of the compressor **(10 Marks)**

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