CBCS SCHEME

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17ME52

Fifth Semester B.E. Degree Examination, July/August 2022
Dynamics of Machinery

Time: 3 hrs. Max. Marks: 100

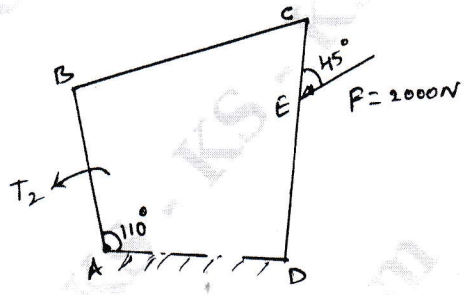
Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. State the condition of equilibrium of a body subjected to a system of
i) Two forces ii) Three forces iii) Two forces and a Torque. **(06 Marks)**

b. For the static equilibrium of the four bar mechanism shown in Fig.Q1(b), determine the input toque T_2 on the link AB for a force of 2000N on link CD. Dimensions are AB = 300mm , BC = 455mm , BE = 175mm. **(14 Marks)**

Fig. Q1(b)



OR

2 a. State D'Alembert's principle and its significance. **(06 Marks)**

b. In slider crank mechanism, the crank is 300mm long and connecting rod 850mm long. The piston is of 90mm in diameter and gas pressure acting on the piston is 5MPa. When the crank has moved through 45° from IDC. Find i) Thrust in connecting rod ii) Reaction from guide (piston side thrust) iii) Torque acting on the crank shaft iv) Load on main bearings. **(14 Marks)**

Module-2

3 a. Explain Static and Dynamic balancing of rotating masses. **(06 Marks)**

b. The four masses A, B, C and D having their radius of rotation as 200mm , 150mm , 250mm and 300mm are 200kg , 300kg , 240kg and 260kg in magnitude respectively. The angle between the successive masses are 45° , 75° and 135° respectively. Determine the position and magnitude of the balance mass required, if it's radius of rotation is 200mm. **(14 Marks)**

OR

4 A four cylinder inline engine has two outer cranks placed at 120° apart and their individual reciprocating masses are 200kg. The distance between cranks are 200mm , 600mm and 500mm respectively. The crank radius is 300mm and the length of connecting rod is 1200mm. The crank rotates at 340 rpm. If the engine is to be in complete primary balance, find the reciprocating masses and the relative angular positions for each of the inner cranks. Also find the magnitude of secondary unbalance force. **(20 Marks)**

Module-3

5 a. Define the following terms with respect to working of governors :
i) Sensitiveness ii) Isochronisms iii) Stability iv) Controlling force. **(08 Marks)**

b. A porter governor has all four arms 300mm long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to a sleeve at a distance of 35mm from the axis. Each ball has a mass of 7kg and the mass of the load on the sleeve is 540 N. Determine the speed of governor at the radius of rotation of the ball is 200mm and 260mm. **(12 Marks)**

OR

6 a. Derive an expression for Gyroscopic couple C = IWWp with usual notations. **(08 Marks)**

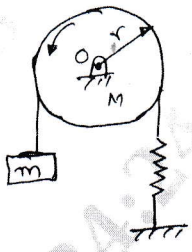
b. Each wheel of a four wheel , rear engine automobile has a moment of Inertia of 2.4kg m^2 and an effective diameters of 660mm. The rotating parts of the engine have a moment of Inertia of 1.2kg m^2. The gear ratio of engine to back axle is 3:1. The engine axis is parallel to the rear axle and the crank shaft rotates in the same sense as the road wheel. The mass of the vehicle is 2200kg and the centre of mass is 550mm above the road level. The track width of the vehicle is 1.5m. Determine the limiting speed of the vehicle around a curve with 80m radius so that all the four wheel maintain contact with the road surface. **(12 Marks)**

Module-4

7 a. Derive the equation for natural frequency of the spring mass system considering the mass of the spring into account. **(10 Marks)**

b. Evaluate the natural frequency of the system shown in Fig. Q7(b) using Newton's method. **(10 Marks)**

Fig. Q7(b)



OR

8 a. Define the following with respect to vibration : i) Natural frequency ii) Resonance iii) Damping factor iv) Logarithmic decrement. **(08 Marks)**

b. A mass of 2kg is supported on a spring of 3kN/m and has a dash pot having damping co-efficient of 5N sec/m. If the initial displacement of 8mm is given, find i) Damped natural frequency ii) Logarithmic decrement iii) Amplitude after 3 cycles. **(12 Marks)**

Module-5

9 a. Derive equation of motion for free damped vibration. **(10 Marks)**

b. A gun barrel , weighing 600kg has a recoil spring of stiffness 345N/mm. If the barrel recoils one meter on firing , find : i) The initial recoil velocity of the gun.
ii) The critical damping co-efficient which is engaged at the end of the recoil stroke.
Assume no energy is lost in the recoil of the barrel. **(10 Marks)**

OR

10 a. Define Logarithmic , Logarithmic decrement and prove that Logarithmic decrement $f = \frac{2\pi\xi}{\sqrt{1-\xi^2}}$, where ξ is damping ratio. **(10 Marks)**

b. Write a short notes on the following :
i) Magnification factor ii) Transmissibility. **(10 Marks)**

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17ME53

Fifth Semester B.E. Degree Examination, July/August 2022
Turbomachines

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of steam table is permitted.***

Module-1

1 a. Distinguish the difference between turbomachines and positive displacement machines. **(10 Marks)**

b. A model of centrifugal pump absorbs 5 kW at a speed of 1500 rpm, pumping water against head of 6 m. The large prototype pump is required to pump water to a head of 30 m. The scale ratio of diameter is 4. Assume same efficiency and similarities. Find (i) Speed (ii) Power of prototype and (iii) ratio of discharge of prototype and model. **(10 Marks)**

OR

2 a. What is Reheat Factor? Show that the Reheat Factor for a turbine is greater than unity. **(10 Marks)**

b. A turbine has three stages and each stage pressure ratio is 2. The inlet static temperature is 600°C. Determine the overall efficiency if the stage efficiency is 75%. Also determine polytropic efficiency power developed and Reheat factor. The mass flow rate is 25 kg/s. **(10 Marks)**

Module-2

3 a. Derive an expression for an Alternate form Euler Turbine equation and explain the different components of energy equation. **(10 Marks)**

b. Define utilization factor and derive an equation establishing a relationship between utilization factor and degree of reaction. **(10 Marks)**

OR

4 a. By analyzing the velocity triangles of an axial flow turbine, show that the maximum utilization factor is given by, $\in_{max} = \frac{2\phi\cos\alpha_1}{1+2\phi R\cos\alpha_1}$

where ϕ is ratio of blade velocity at inlet to the absolute velocity of fluid at inlet and α_1 is nozzle angle and R is degree of reaction. **(10 Marks)**

b. In an axial flow turbine, the discharge blade angles are 20° each for both stator and rotor. The steam speed at the exit of the fixed blade is 140 m/s. The ratio of axial velocity and blade speed is 0.7 at entry and 0.76 at the exit of the rotor blades. Find

(i) The inlet rotor blade angles.
(ii) The degree of reaction.
(iii) Power developed by the blade ring at a mass flow rate of 2.6 kg/s. **(10 Marks)**

Module-3

5 a. What is the necessity of compounding of steam turbine? With a neat schematic sketch, explain any two methods of compounding of steam turbine. **(10 Marks)**

b. The following data refers to Delaval turbine velocity of steam at the exit of the nozzle is 1000 m/s wit a nozzle angle of 20°. The blade velocity is 400 m/s and the blades are equiangular. Assume a mass flow rate of 1080 kg/hour, the friction coefficient is 0.8 and the nozzle efficiency is 95%. Construct the velocity triangle and determine (i) Blade angles (ii) Work done per kg of steam (iii) Power developed (iv) Blade efficiency and (v) Stage efficiency. **(10 Marks)**

OR

6 a. The following data refers to a stage of a reaction turbine. Rotor diameter = 1.5 m, Speed ratio = 0.72, Outlet blade angle = 20°, Rotor speed = 3000 rpm. Determine (i) Diagram efficiency (ii) Percentage increase in diagram efficiency, if the rotor is designed to run at the best theoretical speed. **(10 Marks)**

b. Following particulars referes to Parson's turbine consisting of one ring of fixed blades and one ring of moving blades. The mean diameter of the blade ring is 90 cm and its speed is 3000 rpm. The inlet velocity to blade is 300 m/s, the blade outlet angle is 20° and the steam flow rate is 7.6 kg/s. Calculate (i) Blade inlet angle (ii) Tangential force and (iii) Power developed. **(10 Marks)**

Module-4

7 a. Show that the absolute velocity of Jet is equal to twice the peripheral velocity of vane is the condition required for maximum hydraulic efficiency. Using this condition derive an equation for maximum hydraulic efficiency. **(10 Marks)**

b. Design a Pelton wheel which is required to develop 1500 kW working under a head of 160 m at a speed of 420 rpm. The overall efficiency is 89%. Assume other suitable data. **(10 Marks)**

OR

8 a. The internal and external diameter of an inward flow reaction turbine are 0.6 m and 1.2 m. The head on turbine is 22 m. The velocity of flow is constant throughout and is equal to 2.5 m/s. The guide blade angle is 10° and the runner vanes are radial at inlet. If the discharge at outlet is radial, find (i) Speed of turbine (ii) Vane angle at outlet (iii) Hydraulic efficiency. If the turbine develops 225 kW power, find its specific speed. **(10 Marks)**

b. A Kaplan turbine has outer and hub diameter 4 m and 2 m respectively. It develops 25 MW power when working under a head of 20 m with an overall efficiency of 85% and running at 150 rpm. Find the discharge through the turbine and the runner blade angles at inlet and outlet. Assume hydraulic efficiency of 90%. **(10 Marks)**

Module-5

9 a. With reference to a centrifugal pump, explain briefly the following. Write a schematic sketch, wherever applicable.

(i) Manometric efficiency with expression.
(ii) Cavitation in pumps.
(iii) Pumps connected in series.
(iv) Pumps connected in parallel.
(v) NPSH. **(10 Marks)**

b. Outer diameter of pump is 500 mm and inner diameter is 250 mm. The centrifugal pump is running at 1000 rpm working against a head of 40 m. Velocity of flow is constant and is equal to 2.5 m/s. Vanes are set back at an angle of 40° at outlet and the width at outlet is 50 mm. Find (i) Vane angle at inlet (ii) Work done by the impeller (iii) Manometric efficiency. **(10 Marks)**

OR

10 a. What is the role of a diffuser in a centrifugal compressor? With a neat schematic diagram, explain the 3 different types of diffusers employed in a compressor. **(10 Marks)**

b. A centrifugal compressor runs at a speed of 15000 rpm and delivers 30 kg/s of air. The exit diameter is 70 cm, relative velocity at exit is 100 m/s at an exit angle of 75°. Assume axial entry and inlet total temperature is 300 K, inlet total pressure is 1 bar. Determine

(i) Power required to drive the pump. (ii) Total exit pressure. **(10 Marks)**

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17ME54

Fifth Semester B.E. Degree Examination, July/August 2022
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of design data hand book is permitted.
3. Any missing data may be suitably assumed.

Module-1

1 a. Define Machine design. Briefly explain steps involved in design procedure. **(08 Marks)**

b. Consider a machine member 50mm diameter and 250mm long. It is supported at one end and other end as a cantilever beam. Calculate the principle stress and maximum shear stress for the given load condition. **(12 Marks)**

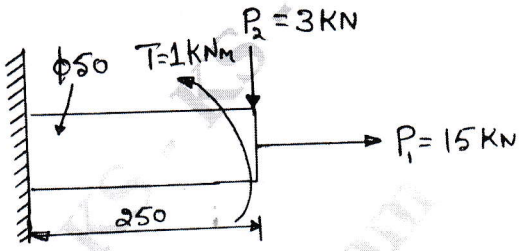

Fig.Q.1(b)

OR

2 a. State and briefly explain four theories of failure. **(04 Marks)**

b. Define stress concentration. Mention any two methods of identifying stress concentration in the components. **(06 Marks)**

c. A stepped shaft of circular cross-section is as shown in figure is made of 20Mn2 steel having σ_y = 432MPa. Determine the value of 'd' and the fillet radius so that the maximum stress will be limited to ratio corresponding to factor of safety 2.5. **(10 Marks)**

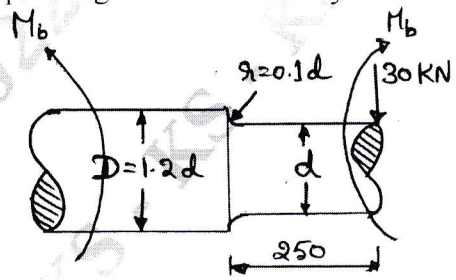

Fig.Q.2(c)

Module-2

3 a. Define impact energy. Derive the equation for impact stress in axial load. **(08 Marks)**

b. A cantilever beam of width 50mm, depth 150mm is 1.5m long. It is struck by a weight of 1000N that falls from a height of 10mm at its free end. Take E = 206.8 × 10^3MPa. Determine impact factor, instaneous deflection, instaneous stress and instaneous load. **(12 Marks)**

OR

4 a. Derive Soderberg equation for designing members subjected to fatigue loads. **(06 Marks)**

b. A steel member of circular cross-section is subjected to a torsional stress that varies from 0 to 35MPa and at the same time, it is subjected to an axial stress that varies from -14MPa to +28MPa. Neglect stress concentration and column effect. Assuming that maximum stress in torsion and axial load occurs at the same time. The material has σ_{on} = 206MPa, σ_y = 480MPa, assume diameter of member is less than 12mm, take load and surface correction as 1. Determine maximum equivalent stress and factor of safety based upon yield in shear. **(14 Marks)**

Module-3

5 A shaft is supported by two bearing placed 1m apart. A 500mm diameter pulley is mounted at a distance of 200mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 3000N. The pulley weighs 1000N. Another pulley 300mm diameter is placed 300mm to the left of right hand bearing is driven with the help of electric motor and the belt is placed horizontally to the right when viewed from the left bearing. This pulley weigh 500N. The angle of contact for both the pulley is 180° and μ = 0.24. Determine suitable diameter for solid shaft, assuming torque on one pulley is equal to torque on other pulley. Choose C15 steel having σ_y = 235.4MPa, σ_u = 425MPa as shaft material. Assume minor shock, use ASME code for design. Take key way effect as 0.75. **(20 Marks)**

OR

6 a. Design and sketch a Spigot and Socket joint to connect two rods of 30C8 steel to carry axial tensile and compressive load of 100kN. Take allowable stresses as σ_t = 90MPa, σ_c = 100MPa, τ = 50MPa. **(12 Marks)**

b. Design a parallel key for a gear shaft of diameter 25mm. 20kW power at 1000rpm is transmitted from the shaft to the gear. The yield strength of key material in tension is 450MPa and factor of safety is 3. The yield strength in compression can be assumed to be equal to yield strength in tension. Determine the dimension of the key. Assume shear stress as 50% of yield stress in tension. **(08 Marks)**

Module-4

7 a. Design a double riveted butt joint with two cover plate for the longitudinal seam of boiler having 12mm plate thickness. Assume an efficiency of 75%, allowable tensile stress in the plate of 83N/mm^2, allowable crushing stress of 138N/mm^2 and allowable shear stress of 55N/mm^2 in rivet. **(13 Marks)**

b. Determine the diameter of rivet for the bracket as shown in Fig.Q.7(b). The allowable normal and shear stress are 120N/mm^2 and 60N/mm^2. **(07 Marks)**

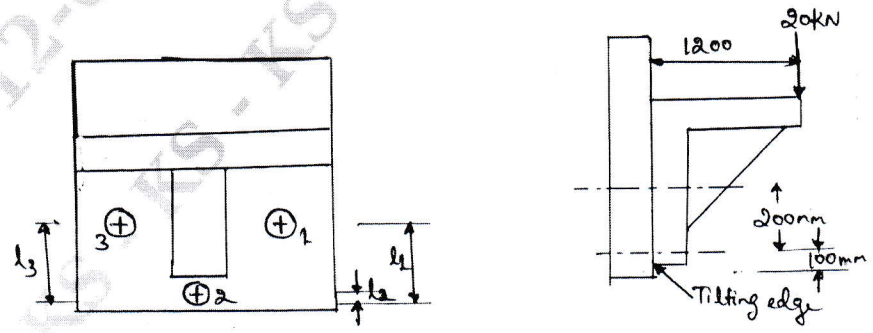

Fig.Q.7(b)

OR

8 a. Determine the size of weld for a eccentrically loaded weld as shown in Fig.Q.8(a). The allowable stress in weld is 75N/mm^2. Take h_t = 1mm. **(12 Marks)**

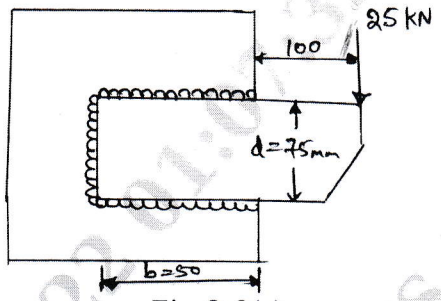

Fig.Q.8(a)

b. A plate of 80mm wide and 15mm thick is joined with another plate by a single transverse weld and a double parallel weld. Determine the length of parallel fillet weld if the joint is subjected to static loading. Take σ_t = 90MPa, τ = 55MPa. **(08 Marks)**

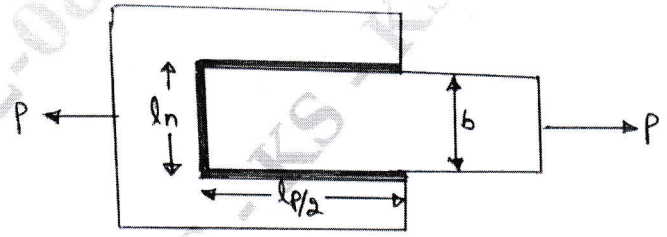

Fig.Q.8(b)

Module-5

9 a. A bolt in a steel structure is subjected to a tensile load of 9kN. The initial tightening load on the bolt is 5kN. Determine the size of bolt taking allowable stresses for the bolt material to be 80MPa and K = 0.05. **(06 Marks)**

b. The structural connection is as shown in Fig.Q.9(b) is subjected to an eccentric load P of 10kN with an eccentricity of 500mm. The centre distance between bolts at 1 and 3 is 150mm and the centre distance between bolt at 1 and 2 is 200mm. All bolts are identical. The bolts are made of plain carbon steel having yield strength in tension of 400MPa and factor of safety is 2.5. Determine size of bolts. **(14 Marks)**

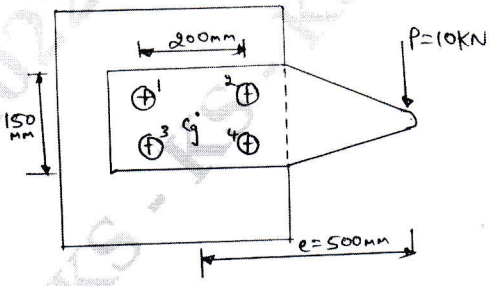

Fig.Q.9(b)

OR

10 Design a screw jack with a lift of 300mm to lift a load of 50kN. Select C40 steel [σ_y = 328.6MPa] for the screw and soft phosphor bronze [σ_{ut} = 345MPa and σ_y = 138MPa] for nut. Take overload = 25%, shear stress as 50% of yield stress. Assume heavy machine oil is used. Assumed factor of safety as 3 for yield, 6 for ultimate strength. **(20 Marks)**

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