CBCS SCHEME

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15ME52

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Explain equilibrium with respect to two force and three force members. **(04 Marks)**

b. Determine the required input torque on the crank of a slider crank mechanism shown in Fig.Q1(b) for static equilibrium.

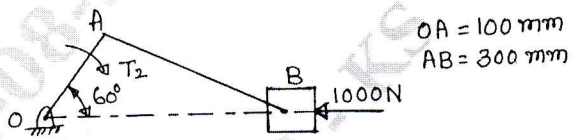

Fig.Q1(b) **(12 Marks)**

OR

2 a. Explain D'Alembert's principle. **(04 Marks)**

b. A slider crank mechanism of a single cylinder diesel engine shown in Fig.Q2(b) is subjected to a gas force of 18000 N. The crank rotates counter clockwise at a constant speed of 1850 rpm. Determine (i) Force F_{14} and F_{12} and the torque T_2 exerted by the crank shaft on the crank for equilibrium. (ii) Magnitude and direction of the shaking force and its location from point O_2. Take $m_2 = 2.5$kg, $m_3 = 3.7$kg, $m_4 = 3$kg, $I_2 = 0.0055$ kg-m^2, $I_3 = 0.041$ kg-m^2.

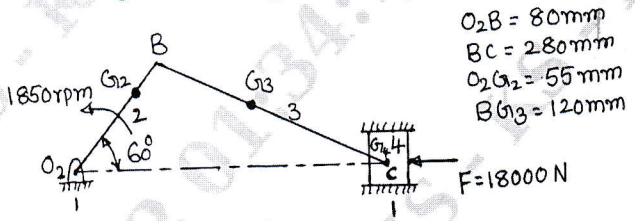

Fig.Q2(b) **(12 Marks)**

Module-2

3 a. Define static and dynamic balancing. **(02 Marks)**

b. A rotating shaft carries four masses A, B, C and D of 10kg, 15kg, 18kg and 20kg at radii 50mm, 60mm, 60mm and 80mm respectively. The masses B, C and D revolve in planes 400mm, 600mm and 800mm respectively measured from plane of mass A and are angularly located at 60°, 145° and 270° respectively measured counter-clockwise from mass A. The shaft is dynamically balanced by two masses located at 50mm radii and revolving in plane L and M placed midway between the masses A and B and midway between those of masses C and D respectively. Determine the magnitude of balance mass and their angular positions. **(14 Marks)**

OR

4 The firing order in a 6-cylinder vertical four stroke in-line engine is 1-4-2-6-3-5. The piston stroke is 100mm and the length of each connecting rod is 200mm. The pitch distances between the cylinder centre lines are 100mm, 100mm, 150mm, 100mm and 100mm respectively. The reciprocating mass per cylinder is 1 kg and the engine runs at 300 rpm. Determine the out of balance primary and secondary forces and couples on this engine, taking a plane midway between the cylinder 3 and 4 as the reference plane. **(16 Marks)**

Module-3

5 a. Define the following :
(i) Isochronism (ii) Sensitiveness. **(02 Marks)**

b. A porter governor has equal arms each 250mm along and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of central load on the sleeve is 25 kg. The radius of rotation of ball is 150mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the range of speed, sleeve lift, governor effort and power of the governor in the following cases:
(i) When the friction at the sleeve is neglected.
(ii) When the friction at the sleeve is equivalent to 10 N. **(14 Marks)**

OR

6 a. With a neat sketches, explain the effect of gyroscopic couple on steering of aeroplane, when it takes a right turn. The runs is clockwise when viewed from rear. **(04 Marks)**

b. Each wheel of a motor cycle is of 600mm diameter and has a moment of inertia of 1.2 kg-m^2. The total mass of the motor cycle and rider is 180 kg and the combined centre of mass is 580mm above the ground level. When the motor cycle is upright. The moment of inertia of the rotating parts of the engine is 0.2 kg-m^2. The engine speed is 5 times the speed of the wheels and is in the same sense. Determine the angle of heel necessary when the motor cycle takes a turn of 35m radius at a speed of 54 kmph. **(12 Marks)**

Module-4

7 a. Define the following :
(i) Periodic motion (ii) Resonance (iii) Degree of freedom (iv) Phase angle **(04 Marks)**

b. Add the following motion analytically and check the solution graphically.
$x_1 = 2\cos(wt + 0.5)$
$x_2 = 5\sin(wt + 1.0)$ **(12 Marks)**

OR

8 a. Determine the Natural frequency of the system shown in Fig.Q8(a).

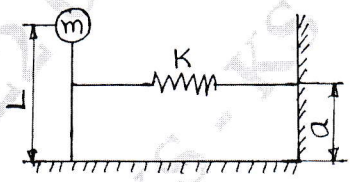

Fig.Q8(a) **(08 Marks)**

b. Find the Natural frequency of the system shown in Fig.Q8(b) by using (i) Newton's method (ii) Energy method.

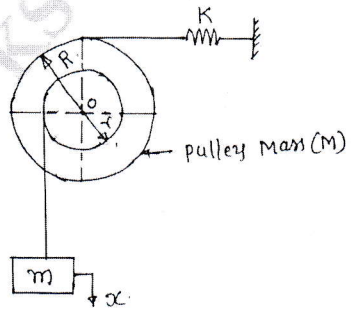

Fig.Q8(b) **(08 Marks)**

Module-5

9 a. Set up the differential equation for a spring mass damper system and obtain the complete solution for the under damped condition. (08 Marks)

b. In a spring mass system, the mass of 10 kg makes 40 oscillation in 20 seconds without damper. With damper the amplitude decreases to 0.20 of the original value after 5 oscillations. Find out (i) Stiffness of the spring (ii) Logarithmic decrement (iii) Damping factor (iv) Actual damping coefficient. (08 Marks)

OR

10 a. Define the term "Transmissibility" derive the expression for transmissibility ratio due to harmonic excitation. (08 Marks)

b. A machine mass one tonn is acted upon by an external force 2450 N at a frequency of 1500 rpm. To reduce the effects of vibration, isolator of rubber having a static deflection of 2 mm under the machine load and an estimated damping factor of 0.2 are used. Determine
(i) Force transmitted to the foundation
(ii) Amplitude of vibration of the machine
(iii) Phase lag of the transmitted force with respect to the external force. (08 Marks)

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15ME53

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

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Describe the parts of a turbomachine with neat sketch. **(08 Marks)**

b. Explain the effect of Reynolds Number in turbomachines. **(04 Marks)**

c. From the performance curves of turbines, its seen that a turbine of one motor diameter acting under a head of one meter, develops a speed of 25 rpm. What diameter should be a prototype have if it is develop 10,000 kW working under a head of 200 m with a specific speed of 150. **(04 Marks)**

OR

2 a. Explain the application of 1st and 2nd law of Thermodynamics to Turbomachines. **(08 Marks)**

b. Explain total to total efficiency and total to static efficiency. **(08 Marks)**

Module-2

3 a. Derive Euler's turbine equation with usual notation. **(08 Marks)**

b. In a radial inward flow turbine, the runner outer diameter is 75 cm and the inner is 50cm. The runner speed is 400rpm. Water enters runner at a velocity of 15 m/s at an angle of 15° to the wheel tangent at inlet. The flow is radial at exit with a velocity of 5 m/s. Find blade angles at inlet and exit. Also find power output for a mass flow rate of 1.5 m^3/s, degree of reaction and utilization factor. **(08 Marks)**

OR

4 a. Define degree of reaction. For an inlet blade angle of 45°, blade speed at exit as twice of that at inlet and a inlet whirl velocity of zero value, prove that $R = \frac{(2+\cot\beta_2)}{4}$

For a radial outward flow turbine where, β = Blade angle at exit, R = Degree of reaction. **(08 Marks)**

b. Show that for maximum utilization of an axial flow turbine with R = ¼ , the speed ratio is given by $\phi = \frac{2}{3}\cos\alpha_1$, where α_1 = Nozzle angle at inlet with respect to tangential direction. **(08 Marks)**

Module-3

5 a. What is compounding? Explain pressure compounding with sketch. **(06 Marks)**

b. A single stage impulse turbine rotor has a diameter of 1.2m running at 3000 rpm. The nozzle angle is 18°, Blade speed is 0.42. The ratio of relative velocity at outlet to relative velocity at inlet is 0.9. The steam flow rate is 5 kg/s. Draw the velocity diagram and find the following: (i) Velocity of whirl (ii) Axial Thrust (iii) Blade angles (iv) Power developed. Take $\beta_2 = \beta_1 - 3°$. **(10 Marks)**

OR

6 a. What is meant by reaction staging? Prove that the maximum stage efficiency of Parson's (50% Reaction) turbine is given by

$$\eta_{smax} = \frac{2\cos^2\alpha_1}{1+\cos^2\alpha_1}$$ **(08 Marks)**

b. The following data refers to a particular stage of a Parson's reaction turbine. Speed of turbine = 1500 rpm, Mean diameter of rotor = 1m, State efficiency = 0.8, Blade outlet angle = 20°, Speed ratio = 0.7. Determine the available isentropic enthalpy drop in the stage. **(08 Marks)**

Module-4

7 a. Explain the working of Francis turbine with neat sketch. Also draw velocity triangles. **(08 Marks)**

b. A Kaplan turbine working under a head of 20 m develops 11772 kW of shaft power, the outer diameter of runner is 3.5m and hub diameter is 1.75 m. The guide blade angle at the extreme edge of the runner is 35°. The hydraulic and overall efficiency of the turbine are 88% and 84% respectively. If the velocity of whirl at outlet is zero. Determine:
i) Runner vane angles
ii) Speed of the turbine. **(08 Marks)**

OR

8 a. Briefly explain the different type of draft tubes with neat sketches. **(08 Marks)**

b. A three jet Pelton turbine is required to generate 10,000 kW under a head of 400m. The blade angle at outlet is 15° and the reduction in relative velocity while passing over the blades is 5%. If overall efficiency of wheel is 80%, $C_v = 0.98$ and speed ratio = 0.46, find (i) Total flow in m^3/s (ii) Discharge through each jet (iii) Diameter of jet (iv) Force exerted by jet on wheel. **(08 Marks)**

Module-5

9 a. For a centrifugal pump, show that the pressure rise in impeller neglecting friction and other losses is

$$(P_1 - P_2) = \frac{1}{2}\left[V_{f_1}^2 + u_{f_2}^2 - V_{f_2}^2 \operatorname{cosec}^2\beta_2\right]$$

where V_{f_1} and V_{f_2} = Velocity of flow at inlet and exit
u_2 = Tangential velocity of Impeller at exit
β_2 = Blade discharge angle. **(08 Marks)**

b. A 4-stage centrifugal pump has impeller each of 38 cm diameter and 1.9 cm wide at outlet. The outlet vane angle is 45° and the vanes occupy 10% of the outlet area. The manometric efficiency is 85% and overall efficiency is 75%. Determine the head generated by the pump when running at 1000 rpm discharging 60 lit/s. Also determine the power required. **(08 Marks)**

OR

10 a. With a neat sketch explain an axial flow compressor. Also sketch the velocity triangles at inlet and exit. **(08 Marks)**

b. A centrifugal compressor runs at 15,000 rpm and produces stagnation pressure ratio of 4 between the impeller inlet and outlet. The stagnation conditions of air at compressor intake are 1 bar, 25°C respectively. The absolute velocity at compressor intake is axial. The compressor has radial blades at exit, such that relative velocity at exit is 135 m/s and total to total efficiency of compressor is 0.78. Draw velocity triangles and compute slip and slip coefficient. Assume rotor diameter of 58 cm. **(08 Marks)**

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15ME54

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

Time: 3 hrs. Max. Marks: 80

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use Data hand book is permitted

Module-1

1 a. Explain the general procedure in machine design. **(06 Marks)**

b. A 40mm diameter steel rod supports 8.0kN load and in addition is subjected to a torsional load of 90Nm as shown in Fig.Q1(b). Determine the maximum tensile and maximum shear stress.

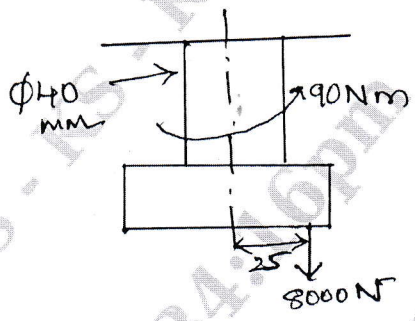

Fig.Q1(b) **(10 Marks)**

OR

2 a. Discuss the statement, in static loading stress concentration in ductile materials is not so serious as in brittle materials. **(04 Marks)**

b. A rectangular plate 15mm thick made of a ductile material is shown in Fig.Q2(b). Calculate the stresses at each of the three holes considering stress concentrations factor.

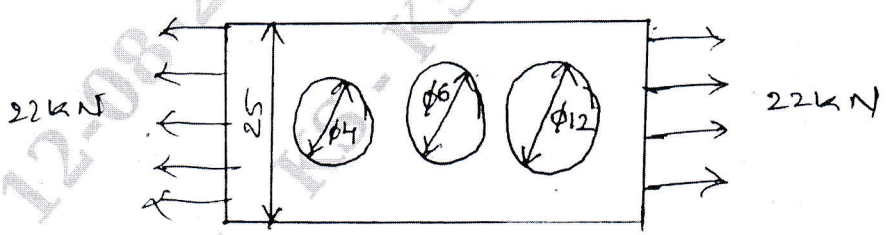

Fig.Q2(b) **(12 Marks)**

Module-2

3 a. Derive an expression for stress induced in the rod due to axial impact of a weight 'w' dropped from a height 'h' on a collar attached at the free end of the rod. **(10 Marks)**

b. An unknown weight falls through 15mm on to a collar rigidly attached to the lower end of a vertical bar 1.5m long and 500sq mm section. If the maximum instantaneous extension is 2mm, what is the corresponding stress and the value of unknown weight? Take E = 200GPa. **(06 Marks)**

OR

4 a. Derive the Soderberg equation for fluctuating loads. **(06 Marks)**

b. A hot rolled steel shaft is subjected to a torsional moment that varies from 250Nm clock wise to 100 Nm counter clockwise and the Bending moment at the critical section varies from 350Nm to 170Nm neglecting stress concentration effect. Determine the required diameter. The material has an ultimate strength of 550MPa and a yield strength of 410MPa. Take the endurance limit as half of ultimate strength and a factor of safety as 2. Assume surface size and load factor for bending as 1.111, 1.1765, 1 and that of torsion as 1.05263, 1.1765 and 1.7 respectively. **(10 Marks)**

Module-3

5 A hoisting drum of 500mm diameter is keyed on to a shaft and is intended for lifting load of 20kN at a velocity of 31.4m/min. The shaft is supported on two bearings and carries a gear of 40mm diameter, overhanging the nearest bearing by 200 mm [i.e 200mm to the right of right hand bearing]. The gear ratio is 12 : 1. Determine the power and revolution per minute of the motor required assuming drive efficiency of 90%. Determine the diameter of the shaft for the hosting drum, assuming that the material of the shaft has an allowable shear stress of 60MPa. The distance between the bearings is 1000mm. Pressure angle = 20°. For suddenly applied load with minor shock the fatigue factor to be applied to the computed bending moment and the numerical combined shock and fatigue factor to be applied to the torsional moment $C_m = K_b = 2$ and $C_t = K_t = 1.3$. Sketch the relevant bending moment diagram. **(16 Marks)**

OR

6 Design a flange coupling (unprotected type) to connect the shafts of a motor and centrifugal pump for the following specifications :
Pump output = 3000 liters per minute, total head = 20m pump speed = 600rpm, pump efficiency = 70%, select C40 steel (σ_y = 328.6MPa) for shaft and key and C35 steel (σ_y = 304MPa) for bolts with factor of safety 2. Use allowable shear stress in flange equal to 15N/mm^2. **(16 Marks)**

Module-4

7 a. Write a note on failure of riveted joints. **(04 Marks)**

b. Design a double riveted butt joint with two cover plates for longitudinal seam of boiler shell of 1.5m diameter subjected to steam pressure of 0.95N/mm^2. Assume efficiency of riveted joint = 75%. Allowable tensile stress is 90MPa, crushing stress = 140N/mm^2 and shear stress = 56MPa. **(12 Marks)**

OR

8 a. What are the advantages of welded joints over riveted joints? **(05 Marks)**

b. A 125 × 95 × 10mm angle shown in Fig.Q8(b) is jointed to a flame by the two parallel welds along the edges of 125mm length. The angle is subjected to a load of 180kN. Find the length of the weld if the permissible load per mm weld length is 430N.

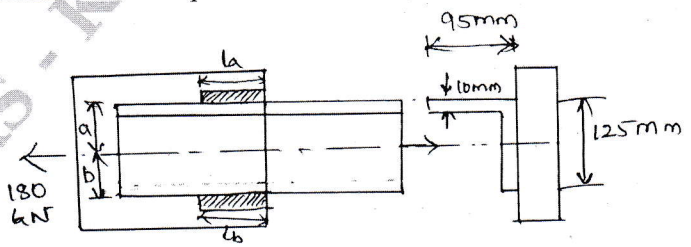

Fig.Q8(b) **(11 Marks)**

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 the bolt taking allowable stress in the bolt material to be 80MPa and K = 0.05. **(04 Marks)**

b. An M10 steel Bolt of 125mm long is subjected to an impact load. The kinetic energy absorbed by the bolt is 2.5J. Determine :

i) Stress in the shank of the bolt if there is no threaded portion between the nut and the bolt head

ii) Stress in the shank if the area of the shank is reduced to that of the root area of the thread or the entire length of the bolt is threaded. **(12 Marks)**

OR

10 A weight of 500kN is raised at a speed of 6m/minute by two screw rods with square threads of 50 × 8 cut on them the two screw rods are driven through bevel gears drives by a motor, determine :

i) Torque required to raise the load
ii) Speed of rotation of the screw rod assuming the threads are of double start
iii) The maximum stresses induced in the cross section of the screw rod
iv) The efficiency of screw drive
v) The length of the nuts for the purpose of supporting the load
vi) Check for overhaul. **(16 Marks)**

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