VTU B.E/B.TECH QUESTION PAPER SET

CBCS
SEMESTER V

DYNAMICS OF MACHINERY

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CBCS Scheme

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15ME52

Fifth Semester B.E. Degree Examination, Dec.2017/Jan.2018
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 the equilibrium with respect to two force of three force member. **(02 Marks)**

b. A four link mechanism with the following dimensions is acted upon by a force 80N 150° on the link DC. Determine the input torque on the link AB for the static equilibrium of the mechanism for the given configuration. AB = 400mm ; BC = 1000mm, CD = 750mm and DE = 350mm, AD = 500mm. **(14 Marks)**

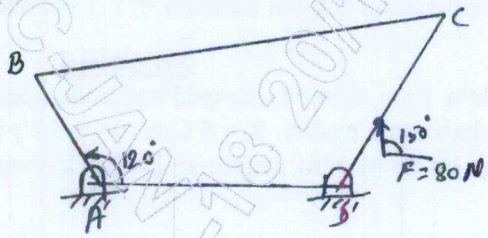

Fig. Q7(b)

OR

2 a. State 'D' Alembert's principle. **(08 Marks)**

b. The crank and connecting rod of a vertical single cylinder gas engine running at 1800 rpm are 60mm and 240mm respectively. The diameter of the Piston is 80mm and the mass of the reciprocating is 1.2kg. At a point during the power stroke when the Piston has moved 20mm from the top dead centre position, the pressure on the Piston is 800 kN/m^2. Determine :

i) Net force on the piston
ii) Thrust in the connecting rod
iii) Thrust on the sides of cylinder wall
iv) Engine speed at which the above values are zero. **(08 Marks)**

Module-2

3 For masses m_1 = 100kg, m_2 = 175kg, m_3 = 200kg and m_4 = 125kg are fixed to the crank of 200mm radius and revolve in planes Ist, IInd, IIIrd respectively. The angular position of the planes IInd, IIIrd and and IVth with respect to Ist plane are 75°, 135° and 240° take in the same sense. Distance of plane IInd, IIIrd and IVth from Ist are 600mm, 1800mm and 2400mm. Determine the magnitude and position of the balancing masses at the radius 600mm in planes L and M located in the middle of Ist and IInd and in the middle of IIIrd and IVth respectively. **(16 Marks)**

OR

4 The piston of a 4 cylinder vertical inline engine reach their upper most position at 90° interval in order of their axial position, pitch of the cylinder = 0.35m ; length of the connecting rod = 0.42m. the engine runs at 600 rpm. If the reciprocating parts of each engine has a mass of 2.5kg. Find the unbalanced primary and secondary forces and couples. Take central plane of engine as reference plane. **(16 Marks)**

Module-3

5 a. Derive an expression for gyroscopic couple. **(06 Marks)**

b. A porter governor has equal arms each 250mm long and pivoted on the axis of rotation. Each ball has a mass of 5kg and the mass of the central load on the sleeve is 25kg. The radius of rotation of the ball is 150mm when the governor begins to lift and 200mm when the governor is at maximum speed. Find the minimum and maximum speeds and range of speed of the governor. **(10 Marks)**

OR

6 a. Define: i) Sensitiveness ii) Isochronism. **(04 Marks)**

b. A turbine rotor of a ship has a mass of 2.2 and Tonnes and rotates at 1800rpm clockwise when viewed from the stern. The radius of gyration of the rotor is 320mm. Determine the gyroscopic couple and its effect when the

i) Ship turns right at a radius of 250m with a speed of 25km/hr.

ii) Ship pitches with bow rising at on angular velocity of 0.8 rad/sec.

iii) Ship rolls at on angular velocity of 0.1 rad/sec. **(12 Marks)**

Module-4

7 a. Briefly explain, Free, Forced, damped and undamped vibration. **(08 Marks)**

b. Split up the harmonic motion $X = 6 \cos (wt + 45°)$ into two harmonic motions. One of them having phase angle of zero degree and other having phase angle of 60°. Check solution by graphically. **(08 Marks)**

OR

8 a. Obtain the equivalent stiffness of spring when springs are connected in series and parallel. **(08 Marks)**

b. Obtain the natural frequency of the system shown in Fig Q8 (b). **(08 Marks)**

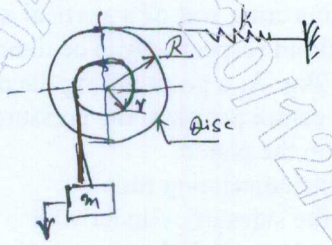

Fig. Q8(b)

Module-5

9 a. Define logarithmic decrement and derive the equation for same. **(08 Marks)**

b. Vibration system consisting of a mass 3kg a springs of stiffness 100kN/m and damper. Damping coefficient 30Ns/m. Determine Damping factor, critical damping coefficient logarithmic decrements, Ratio of two consecutive amplitudes.
Number of cycles after which the initial amplitude is reduced to 20%? **(08 Marks)**

OR

10 a. Derive an expression for magnification factor or amplitude ratio for spring mass system with viscous damping subjected to harmonic force. **(08 Marks)**

b. A vibratery body of mass 150kg supported on springs of total striffness 1050kN/m has a rotating unbalance force fo 525N at a speed of 6000rpm. If the damping factor is 0.3. Determine :

i) The amplitude caused by the unbalance and its phase angle

ii) The transmissibility

iii) The actual force transmitted and its phase angle. **(08 Marks)**

CBCS Scheme

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15ME52

Fifth Semester B.E. Degree Examination, June/July 2018
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. State the condition for static equilibrium of a body subjected to a system of,
(i) Two forces (ii) Three forces (iii) Member with two forces and a torque. **(06 Marks)**

b. For the mechanism shown in Fig. Q1 (b), find the required input torque for the static equilibrium. The length of OA and AB are 250 mm and 650 mm respectively. F = 500 N. **(10 Marks)**

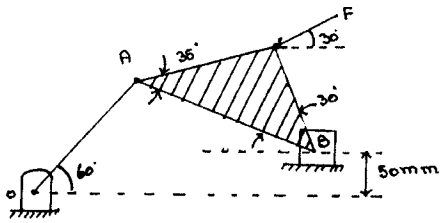

Fig. Q1 (b)

OR

2 a. Explain in brief D'Alembert's principle and state why it is used. **(06 Marks)**

b. In a vertical double acting engine, the connecting rod is 4.5 times the crank. Stroke of the piston is 400 mm and the mass of the reciprocating parts is 100 kg. The engine runs at 250 rpm. If the net load on the piston due to steam pressure is 25 kN when the crank has turned through an angle of 120° from the top dead centre, determine
(i) Piston effort.
(ii) Thrust in the connecting rod
(iii) Pressure on slide bars.
(iv) Crank pin effort
(v) Thrust on crank shaft bearing
(vi) Turning moment on the crank shaft. **(10 Marks)**

Module-2

3 a. Briefly explain the static and dynamic balancing. **(04 Marks)**

b. Four masses A, B, C and D are carried by a rotating shaft at a radii 100 mm, 125 mm, 200 mm and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B,C and D are 10 kg, 5 kg and 4 kg respectively. Find the required mass 'A' and the relative angular positions of the four masses. So that the shaft shall be in complete balance. **(12 Marks)**

OR

4 a. What do you mean by primary and secondary unbalance in reciprocating engines? **(04 Marks)**

b. The Cranks and connecting rod of a 4 cylinder in line engine running at 1800 rpm, are 50 mm, 250 mm each respectively and the cylinders are spaced 150 mm apart. If the cylinders are numbered 1 to 4 in sequence from one end and the cranks appear at intervals of 90° in an end view in the order 1 – 4 – 2 – 3. The reciprocating masses corresponding to each cylinder is 1.5 kg. Determine
(i) Unbalanced primary and secondary forces if any.
(ii) Unbalanced primary and secondary couples with reference to central plane of engine. **(12 Marks)**

Module-3

5 a. Derive the expression for speed of a porter governor with usual notations taking friction in to account. **(06 Marks)**

b. In a porter governor, the upper and lower arms are 200 mm and 250 mm respectively and pivoted on the axis of rotation. The mass of central load is 15 kg, the mass of each ball is 2 kg and friction of the sleeve together with the resistance of the operating gear is equal to a load of 24 N at the sleeve. If the limiting inclinations of the upper arms to the verticals are 30° and 40°. Find the range of speed taking friction in to account. **(10 Marks)**

OR

6 a. Explain the effect of Gyroscopic couple of a ship under,
(i) Steering (ii) Pitching (iii) Rolling **(08 Marks)**

b. Analyse the stability of a two wheel vehicle turning right. Derive the necessary equation. **(08 Marks)**

Module-4

7 a. Define the following terms:
(i) Simple harmonic motion (ii) Resonance.
(iii) Degrees of freedom (iv) Phase difference. **(04 Marks)**

b. With a neat sketch, explain the beats phenomenon and obtain it's resultant motion. **(06 Marks)**

c. Add the following motions analytically and check the solution graphically,
$x_1 = 2\cos(\omega t + 0.5)$; $x_2 = 5\sin(\omega t + 1.0)$ **(06 Marks)**

OR

8 a. Explain energy method of finding natural frequency of a spring mass system. **(06 Marks)**

b. Find the natural frequency of the system shown in Fig. Q8 (b), by using Newtons method and Energy method. **(10 Marks)**

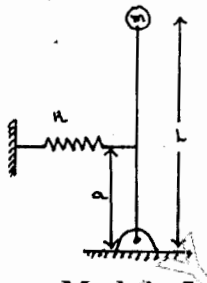

Fig. Q8 (b)

Module-5

9 a. Set up the differential equation for a spring mass Damper system and obtain complete solution for the under damped system. **(10 Marks)**

b. For a spring mass damper system of mass 3.5 kg; spring of stiffness 2.5 N/mm and damping co-efficient of 0.018 N-S/mm. Find
(i) Logarithmic decrement (ii) Ratio of any two successive amplitude
(iii) Number of cycles after which original amplitude reduces to 20%. **(06 Marks)**

OR

10 a. Derive expression for steady state amplitude of vibration of mass in a spring mass damper system, when the mass is subjected to harmonic excitation. Also find phase angle. **(10 Marks)**

b. A pump of 200 kg is driven through a belt by an electric motor at 3000 rpm. The pump is mounted on isolators with total stiffness 5 MN/m and damping 3.125 kN-S/m. Determine the vibratory amplitude of the pump at the running speed due to harmonic force of 1 kN. Also determine maximum amplitude when the pump is switched on and the motor speed passes through resonant condition. **(06 Marks)**

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15ME52

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.2019
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. State the condition for static equilibrium of a body subjected to a system of
i) two forces ii) three forces iii) member with two forces and a torque. **(06 Marks)**

b. For the 4 bar mechanism shown in Fig.Q.1(b), find the required torque T_2 and various P in forces on the links for the equilibrium of the system. **(10 Marks)**

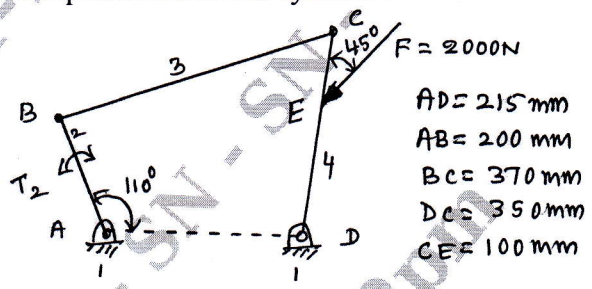

Fig.Q.1(b)

OR

2 a. Explain D'Almerts principle and state its significance. **(04 Marks)**

b. In a vertical double acting steam engine, the connecting rod is 4.5 times the crank. The weight of the reciprocating parts is 120kg and the stroke of the Piston is 440mm. The engine runs at 250rpm. If the net load on the Piston due to steam pressure is 25kN when the crank has turned through an angle of 120° from the top dead centre, determine:
i) Thrust in the connecting rod
ii) Pressure on slide bars
iii) Tangential force on the crank pin
iv) Thrust on the bearings
v) Turning moment on the crank shaft. **(12 Marks)**

Module-2

3 a. What do you mean by static and dynamic balancing? **(04 Marks)**

b. A, B, C and D are 4 masses carried by a rotating shaft at radii 100, 125, 200 and 150mm respectively. The planes in which the masses revolve are spaced 600mm apart and the mass of B, C and D are 10kg, 5kg and 4kg respectively. Find the required mass A and the relative angular settings of the 4 masses so that the shaft shall be in complete balance. **(12 Marks)**

OR

4 A four crank engine has the two outer cranks set at 120° to each other, and their reciprocating masses are each 400kg. The distance between the planes of rotation of adjacent cranks are 450mm, 750mm and 600mm. If the engine is to be in complete primary balance, find the reciprocating mass and the relative angular position for each of the inner cranks. If the length of each crank is 300mm, the length of each connecting rod is 1.2m and the speed of rotation is 240rpm. What is the maximum secondary unbalanced force? **(16 Marks)**

Module-3

5 a. Explain the following terms relative to governors: i) Stability ii) Sensitiveness iii) Isochronism iv) Hunting. **(08 Marks)**

b. A porter governor has equal arms each 250mm long and pivoted on the axis of rotation. Each ball has a mass of 5kg and the mass of the central load on the sleeve is 15kg. The radius of rotation of the ball is 150mm when the governor begins to lift and 200mm when the governor is at maximum speed. Find the minimum and maximum speeds and the range of speed of the governor. **(08 Marks)**

OR

6 a. With neat sketches, explain the effect of gyroscopic couple on steering, pitching and rolling of a ship. **(06 Marks)**

b. An aeroplane flying at 240km/h turns towards the left and completes a quarter circle of 60m radius. The mass of the rotor engine and the propeller of the plane is 450kg with a radius of gyration of 320mm. The engine speed is 2000 rpm clockwise when viewed from the rear. Determine the gyroscopic couple on the aircraft and its effect. In what way is the effect changed when the

i) Aeroplane turns towards right

ii) Engine rotates clockwise when viewed from the front (nose end) and the aeroplane turns left and right. **(10 Marks)**

Module-4

7 a. Add the following harmonic motions analytically and check the solutions graphically:

$x_1 = 4\cos(wt + 10°)$

$x_2 = 6\sin(wt + 60°)$ **(08 Marks)**

b. Find the natural frequency of the system shown in the Fig.Q.7(b) using energy method. **(08 Marks)**

Fig.Q.7(b)

OR

8 a. Find the natural frequency of the system shown in Fig.Q.8(a) using Newton's method. **(08 Marks)**

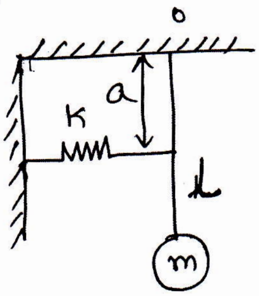

Fig.Q.8(a)

b. Find the natural frequency of the system shown in Fig.Q.8(b), K = 2×10^5 N/m, m = 20kg. **(08 Marks)**

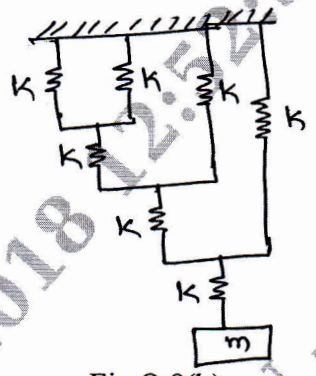

Fig.Q.8(b)

Module-5

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

b. Determine:

i) Critical damping coefficient
ii) Damping factor
iii) Natural frequency of damped vibrations
iv) Logarithmic decrement
v) Ratio of two consecutive amplitude of vibrating system which consists of mass of 25kg, a spring of stiffness 15 kN/m and a damper. The damping provided is only 15% of the critical value. **(08 Marks)**

OR

10 a. Define transmissibility and derive an expression for the transmissibility ratio and the phase angle for transmitted force. **(08 Marks)**

b. A machine of mass one ton is acted upon by an external force 2450N at a frequency of 1500rpm. To reduce the effects of vibration, isolator and rubber having a static deflection of 2mm 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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CBCS SCHEME

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Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Dynamics of Machines

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Considering slider crank mechanism, state and explain principle of virtual work. **(06 Marks)**

b. A four bar mechanism shown in Fig.Q1(b) is acted by a force P = 100, ∠120°N on link CD. The dimensions of the various links are AB = 40 mm, BC = 60 mm, CD = 50 mm, DA = 30 mm and DE = 20 mm. Determine the magnitude and direction of input torque T_2 on link AB for the static equilibrium of the mechanism.

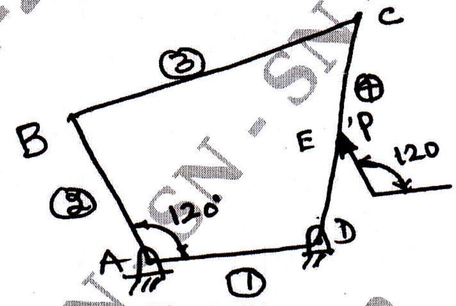

Fig.Q1(b) **(10 Marks)**

OR

2 a. Explain in brief D'Alembert's principle and state why it is used. **(06 Marks)**

b. A horizontal gas engine running at 240 rpm has a bore of 500 mm and stroke of 600 mm. The length of connecting rod is 1.2 m and mass of reciprocating parts is 200 kg. The difference between driving and back pressure is 0.4 N/mm^2, when the crank has turned an angle of 60° from inner dead center. Neglecting the affect of piston rod, determine:
(i) Net force on the piston or piston effort.
(ii) Thrust in the connecting rod
(iii) Pressure in the slide bars
(iv) Tangential force on the crank pin
(v) Thrust on the bearings
(vi) Turning movement on the crank shaft
(vii) Acceleration of the flywheel which has mass of 100 kg and radius of gyration of 500 mm, while the power of the engine is 100 KW. **(10 Marks)**

Module-2

3 A rotor has the following properties:

Mass	Magnitude (kg)	Radius (mm)	Angle (degrees)	Axial distances from 1st mass (mm)
1	9 kg	100 mm	0°	-
2	7 kg	120 mm	60°	160 mm
3	8 kg	140 mm	135°	320 mm
4	6 kg	120 mm	270°	560 mm

If the shaft is balanced by two counter masses located at 100 mm radius r and revolving in planes midway of planes 1 and 2 and midway of 3 and 4, determine the magnitude of the masses and their respective angular position. **(16 Marks)**

OR

4 A four crank engine has two outer cranks set at 120° to each other and their reciprocating masses are each 400 kg. The distance between planes of rotation of adjacent cranks are 450 mm, 750 mm and 600 mm. If the engine is to be in complete balance, find the reciprocating mass and the relative angular position for each of the inner cranks. If the length of each crank is 300 mm, the length of each connecting rod is 1.2 m and the speed of rotation is 240 rpm, find maximum secondary unbalanced force. **(16 Marks)**

Module-3

5 a. Define the term stability and sensitivity of a governor. **(06 Marks)**

b. In an engine governor of the porter type, the upper and lower arms are 200 mm and 250 mm respectively and pivoted on the axis of rotation. The mass of the center load is 15 kg, the mass of each ball is 2 kg and friction of sleeve together with a resistance of the operating gear is equal to a load of 25 N at the sleeve. If the limiting inclination of the upper arms to the vertical are 30° and 40°, find taking friction into account, range of speed of the governor. **(10 Marks)**

OR

6 a. With neat sketches, explain the affect of gyroscopic couple on steering, pitching and rolling of a ship. **(08 Marks)**

b. An aeroplane flying at a speed of 300 kmph takes right turn with a radius of 50 meter. The mass of engine and propeller is 500 kg and radius of gyration is 400 mm. If the engine runs at 1800 rpm in clockwise direction, when viewed from tail end, determine the gyroscopic couple and state its effect on the aeroplane. What will be the effect, if the aeroplane turns to left instead of right? **(08 Marks)**

Module-4

7 a. Define the following terms:
(i) Harmonic motion (ii) Natural frequency
(iii) Amplitude (iv) Damping **(08 Marks)**

b. Add the following harmonic motions and check the solution graphically:
$x_1 = 2\cos(\omega t + 0.5)$ $x_2 = 5\sin(\omega t + 1.0)$ **(08 Marks)**

OR

8 a. Find the natural frequency of spring-mass system considering inertia effect of the mass of the spring. **(08 Marks)**

b. Find the natural frequency of the Fig.Q8(b).

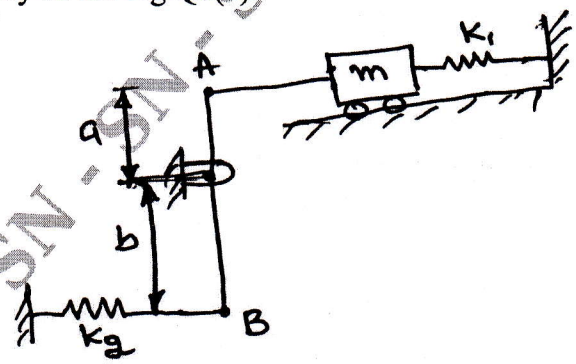

Fig.Q8(b) **(08 Marks)**

Module-5

9 a. Define logarithmic decrement and prove that logarithmic decrement $'\delta' = \frac{2\pi\xi}{\sqrt{1-\xi^2}}$ where ξ is damping ratio. **(07 Marks)**

b. The measurement on a mechanical vibrating system shows that the mass of 10 kg and that the springs can be combined to give an equal spring stiffness 5 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N, when the mass have a unit velocity of 1 m/sec. Determine:
(i) Critical damping coefficient
(ii) Damping factor
(iii) Logarithmic decrement
(iv) Ratio of any consecutive amplitudes. **(09 Marks)**

OR

10 a. Write short notes on the following:
(i) Magnification factor
(ii) Transmissibility. **(06 Marks)**

b. A single cylinder vertical diesel engine has a total mass of 100 kg is mounted on a steel chassis frame. The static deflection owing to the weight of the chassis is 3 mm. The reciprocating masses of the engine amounts to 10 kg and the stroke of the engine 80 mm. A dashpot with a damping coefficient of 2 N/mm/sec is used to dampen the vibration. Determine:
(i) amplitude of the vibration, if the driving shaft rotates at 1000 rpm,
(ii) speed of the driving shaft, when resonance occurs. **(10 Marks)**

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CBCS SCHEME

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15ME52

Fifth Semester B.E. Degree Examination, Aug./Sept. 2020
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. State the conditions for static equilibrium of a body subjected to a system of, (i) two forces (ii) Three forces. **(04 Marks)**

b. For the static equilibrium of the quick return mechanism shown in Fig. Q1 (b). Find the required input torque T_2 for a force of 3500 N on the slider. Angle of EB with the vertical is 70°. The impending motion of the slider is to the lift. **(12 Marks)**

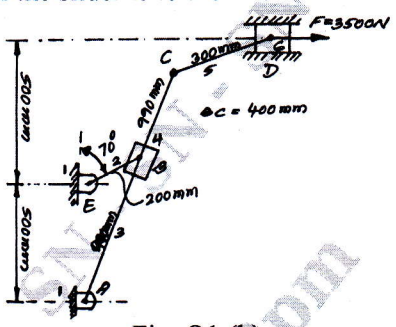

Fig. Q1 (b)

OR

2 a. What do you mean by inertia force and inertia torque? **(04 Marks)**

b. A four bar mechanism shown in Fig. Q2 (b) has the following length of various links O_2O_4 = 800 mm, O_2B = 330 mm, BC = 500 mm, O_4C = 400 mm, O_2G_2 = 200 mm, BG_3 = 250 mm, O_4G_4 = 200 mm. The masses of links are m_2 = 2.2 kg, m_3 = 2.5 kg, m_4 = 2 kg. The moment of inertia of links about their C.G are I_2 = 0.05 kg-m^2, I_3 = 0.07 kg-m^2. The crank O_2B rotates at 100 rad/s^2. Neglecting gravity effects, determine the forces in the joints and the input torque. **(12 Marks)**

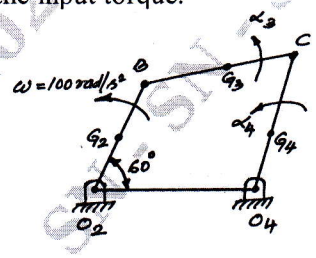

Fig. Q2 (b)

Module-2

3 a. What do you mean by static balancing and dynamic balancing? **(04 Marks)**

b. A rotating shaft carries 4 masses A, B, C and D at radii 100, 125, 200 & 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the masses B, C and D having 10, 5 and 4 kg respectively. Find the required mass A and relative angular positions of 4 masses to keep the shaft in balance. **(12 Marks)**

OR

4 The cranks and connecting roads of a 4-cylinder in line engine running at 1800 rpm are 60 mm and 240 mm. Each respectively and the cylinder are spaced 150 mm apart. If the cylinders are numbered 1 to 4 in sequence from one end, the cranks appear at intervals of 90° in an End view in the order 1 – 4 – 2 – 3. The reciprocating mass corresponding to each cylinder is 1.5 kg. Determine

(i) Unbalanced primary and secondary force.

(ii) Unbalanced primary and secondary couples with reference to control plane of the engine. **(16 Marks)**

Module-3

5 a. Define the following: (i) Sensitiveness (ii) Hunting (iii) Isochronism (iv) Effort of governor (v) Stability of governor (vi) Power of governor. **(06 Marks)**

b. A loaded governor of the porter type has equal arms and links each 300 mm long. The weights of each ball is 20 N and the central weight is 120 N. When the ball radius is 150 mm, the valve is fully open and when the radius is 180 mm, the value is closed. Find the maximum speed and the range of speed. If the maximum speed is to be increased 25% by an addition of weight to the central load, find its valve. **(10 Marks)**

OR

6 a. Derive an expression for the gyroscopic couple $C = IWW_P$ from first principle. **(06 Marks)**

b. A four wheeled trolley car has a total mass of 3000 kg. Each axle with its two wheels and gears has a total M.I. of 32 kg-m^2. Each wheel is of 450 mm radius. The centric distance between two wheel is 1.4 m. Each axle is driven by a motor with speed ratio of 1 : 3. Each motor along with its gear has a M.I of 16 kg-m^2 and rotates in the opposite direction to that of axle. The centre of mass of the car is 1 m above the rails. Calculate the limiting speed of the car when it has to travel around curve of 250 m radius without the wheels leaving the rails. **(10 Marks)**

Module-4

7 a. Define vibration. Give the classification of vibration. **(05 Marks)**

b. Add the following harmonic motions and check the solution graphically $x_1 = 2\cos(wt + 0.5)$, $x_2 = 5\sin(wt + 1.0)$. **(11 Marks)**

OR

8 a. Determine the natural frequency of the spring mass system considering mass of the spring. **(08 Marks)**

b. Find the natural frequency of the system as shown in Fig. Q8 (b). Solve by energy method. **(08 Marks)**

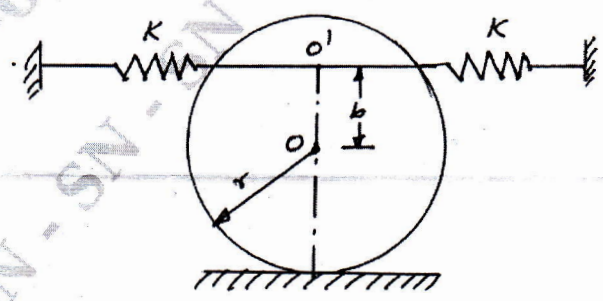

Fig. Q8 (b)

Module-5

9 a. Define damping. Explain different types of damping with neat sketches. **(10 Marks)**

b. Show that the ratio of successive amplitudes of mass in a under damped, viscously damped spring mass system is given by $\frac{x_0}{x_1} = e^{\delta}$ where $\delta = \frac{2\pi\xi}{\sqrt{1-\xi^2}}$. **(06 Marks)**

OR

10 a. Write a note on vibration isolation and transmissibility. Explain the influence of frequency ratio on transmissibility. **(08 Marks)**

b. A weight of 60 N suspended by a spring of stiffness 1.2 kN/m is forced to vibrate by a harmonic force of 10 N. Assuming viscous damping of 0.086 kN-s/m. Determine

(i) The resonant frequency.
(ii) Amplitude at resonance.
(iii) Phase angle at resonance.
(iv) Frequency corresponding to peak amplitude.
(v) Peak amplitude. **(08 Marks)**

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CBCS SCHEME

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17ME52

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
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. Enumerate the concept of static equilibrium of a body subjected to a system of (i) Two forces (ii) Three forces (iii) Member with two forces and a torque **(06 Marks)**

b. A four bar mechanism is shown in Fig.Q1(b), which is acted upon by a force $P = 100 \angle 120^\circ$ N on link CD. The dimensions of various link are AB = 40 mm, BC = 60 mm, CD = 50 mm, DA = 30 mm and DE = 20 mm. Determine the magnitude and direction of input torque T_2 on link AB for static equilibrium of the mechanism.

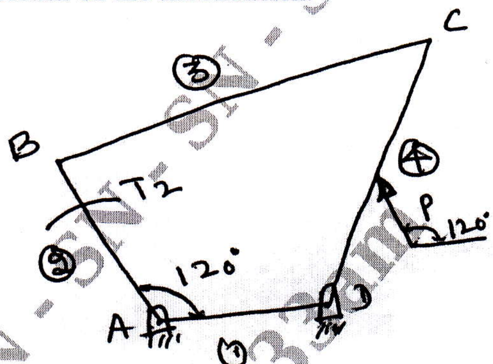

Fig.Q1(b) **(14 Marks)**

OR

2 a. Explain the D'Alembert's principle and discuss on its significance. **(04 Marks)**

b. In a vertical double acting engine, the connecting rod is 4.5 times the crank. Stroke of the piston is 400 mm and the mass of the reciprocating parts is 100 kg. The engine runs at 250 rpm. If the net load on the piston due to steam pressure is 25 kN, when the crank has turned through an angle of 120° from top dead centre. Determine :

(i) Net force on the piston
(ii) Thrust in the connecting rod along connecting rod
(iii) Thrust on the sides of cylinder walls
(iv) Crank pin effort
(v) Thrust on crank shaft bearing
(vi) Turning moment on the crank shaft **(16 Marks)**

Module-2

3 a. Discuss on the concept of static and dynamic balancing. **(04 Marks)**

b. Four masses A, B, C and D are completely balanced. Masses C and D make angles of 90° and 210° respectively with B in the same sense. The plane containing B and C are 300 mm apart. Masses A, B, C and D can be assumed to be concentrated at radii of 360 mm, 480 mm, 240 mm and 300 mm respectively. The massed B, C and D are 15 kg, 25 kg and 20 kg respectively. Determine:

(i) Mass A and its angular position
(ii) Position of planes A and D. **(16 Marks)**

OR

4 A four crank engine has two outer cranks set at 120° to each other and their reciprocating masses are 400 kg each. The distance between the planes of rotation of adjacent cranks are 450 mm, 750 mm and 600 mm. If the engine is to be incomplete primary balance, find the reciprocating mass and the relative angular position for each of the inner cranks. If the length of each crank is 300 mm, length of each connecting rod is 1.2 m and the speed of rotation is 240 rpm, what is the maximum secondary unbalanced force? **(20 Marks)**

Module-3

5 a. Explain the following term relative governors:
(i) Stability
(ii) Sensitiveness
(iii) Isochromism
(iv) Hunting **(04 Marks)**

b. The arms of a porter governor are each 250 mm long and pivoted on the governor axis. The mass of each ball is 5 kg and the mass of central sleeve is 30 kg. The radius of rotation of the balls is 150 mm, when the sleeve begins to rise and reaches a value of 200 mm for maximum speed. Determine the range of the Governor. If the friction at the sleeve is equivalent of 20 N of load at the Sleeve. Determine how the speed range is modified. **(16 Marks)**

OR

6 a. With neat sketches, enumerate on the effect of Gyroscopic couple on the steering, pitching and rolling of a ship. **(09 Marks)**

b. A ship is propelled by a rotor of mass of 2000 kg rotates at a speed of 2400 rpm. The radius of gyration of rotor is 0.4 m and spins clockwise direction, when viewed from bow (Front) end. Find the gyroscopic couple and its effect when
(i) The ship takes left turn at a radius of 350 m with a speed of 35 kmph.
(ii) The ship pitches with the bow rising at angular velocity of 1 rad/sec.
(iii) The ship rolls at an angular velocity of 0.15 rad/sec. **(11 Marks)**

Module-4

7 a. Define the following terms:
(i) Simple Harmonic Motion
(ii) Resonance
(iii) Natural frequency
(iv) Phase difference **(08 Marks)**

b. Add the following harmonic motions analytically and check the solution graphically:
$x_1 = 4\cos(\omega t + 10°)$ and $x_2 = 6\sin(\omega t + 60°)$ **(12 Marks)**

OR

8 a. Explain the energy method of finding natural frequency of spring-mass system. **(10 Marks)**

b. Find the natural frequency of the system shown in Fig.Q8(b).

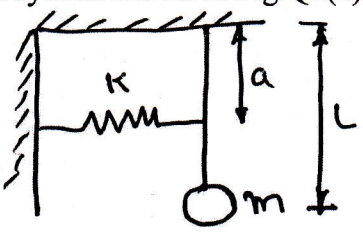

Fig.Q8(b) **(10 Marks)**

Module-5

9 a. Set up a differential equation for a spring mass damper system and obtain complete solution for a under damped system. **(10 Marks)**

b. The measurement on a mechanical vibrating system shows that the mass of 10 kg and that the spring can be combined to give an equal spring stiffness of 5 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass have a unit velocity of 1 m/sec. Determine:

(i) Critical damping coefficient
(ii) Damping factor
(iii) Logarithmic decrement
(iv) Ratio of any two consecutive amplitude **(10 Marks)**

OR

10 a. Derive an expression for magnification factor or amplitude ratio for spring mass system with viscous damping subjected to Harmonic force. **(10 Marks)**

b. A mass of 100 kg has been mounted on a spring dash pot system having stiffness of 19,600 N/m and damping coefficient 100 N-S/m. The mass acted upon by a harmonic force of 39 N at the undamped natural frequency of the system. Find:

(i) Amplitude of vibration of the mass
(ii) Phase difference between the force and displacement
(iii) Force transmissibility ratio **(10 Marks)**

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17ME52

Fifth Semester B.E. Degree Examination, Aug./Sept.2020
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 conditions for the equilibrium of the following systems:
i) Two force member
ii) Three force member
iii) Member with two forces and a torque. **(06 Marks)**

b. In the slider crank mechanism shown in Fig.Q.1(b). The value of force applied to slider 4 is 2kN the dimensions of the various links are AB = 80mm, BC = 240mm, θ = 60°. Determine the forces on various links and the driving torque T_2. **(14 Marks)**

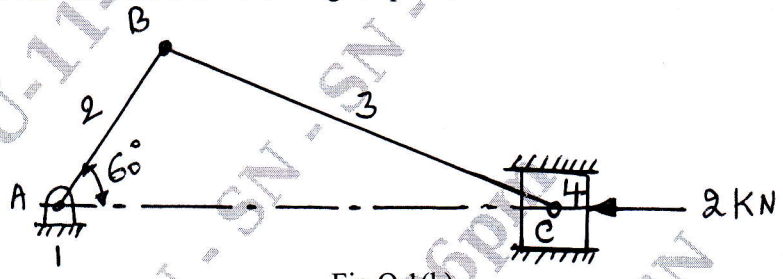

Fig.Q.1(b)

OR

2 a. What is the principal of virtual work? Explain. **(06 Marks)**

b. A four bar mechanism under the action of external force is shown in Fig.Q.2(b). Determine the torque T_2 and various forces on links for the equilibrium of the system. F = 2000N at 45° on CD, AB = 200mm, AD = 215mm, BC = 370mm, DC = 350mm, CE = 100mm. **(14 Marks)**

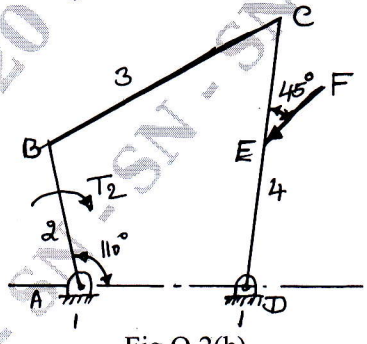

Fig.Q.2(b)

Module-2

3 a. Explain briefly static and dynamic balancing of rotating masses. **(04 Marks)**

b. A, B, C and D masses carried by a rotating shaft at radius 100, 125, 200 and 150mm respectively. The planes in which the masses revolving are spaced 600mm apart and the masses B, C and D are 10, 5, 4kg respectively. Find the required mass A and the relative angular positions of the masses to keep the shaft in balance. **(16 Marks)**

OR

4 Crank and connecting rods of a 4 cylinder inline engine running at 1800rpm are 60mm and 240mm respectively and the cylinders are spaced 150mm apart. If the cylinders are numbered 1 to 4 in sequence from one end. The cranks appear at intervals of 90° in an view in the order 1-4-2-3. Reciprocating mass corresponding to each cylinder is 1.5kg. Determine:

a. Unbalanced primary and secondary forces

b. Unbalanced primary and secondary couples with reference to central plane of the engine.

(20 Marks)

Module-3

5 a. Derive an expression for the equilibrium speed of a porter governor. **(06 Marks)**

b. The arms of a porter governor are each 300mm long and are hinged on the axis of rotation. The mass of each ball is 5kg and mass of the sleeve is 15kg. The radius of rotation of the ball is 200mm when the governor begins to lift and 250mm when the governor is at the maximum speed. Determine:

i) Range of speed neglecting the sleeve friction

ii) Range of speed if the frictional force at the sleeve is 30N. **(14 Marks)**

OR

6 a. With usual notations and diagram derive an expression for the gyroscopic couple produced by a rotating disc: **(06 Marks)**

b. A rare engine automobile is travelling along a track of 100m mean radius each of the four road wheels has a mass moment of inertia 2kg-m^2 and effective diameter of 600mm. The rotating parts of the engine have a moment of inertia of 1kg-m^2. The engine axles parallel to the rare axle. When the crank shaft rotates in the same sense as the road wheels, the gear ratio of engine to back axle is 3:1. The vehicle weighs 15000N and has its centre of gravity 500mm above the road level. Determine the limiting speed of the vehicle around the curve for all 4-wheels to maintain contact with the road surface if this is not cambered. **(14 Marks)**

Module-4

7 a. Define the following:

i) Time period

ii) Amplitude

iii) Frequency **(06 Marks)**

b. A body is subjected to two harmonic motions as given below:

$x_1 = 15\sin(wt + 30°)$

$x_2 = 8\cos(wt + 60°)$

Add the two harmonic motions and check it graphically. **(14 Marks)**

OR

8 a. A spring mass system has spring stiffness of K N/m and a mass of M kg. It has a natural frequency of vibration as 10Hz. An extra 3 kg mass is coupled to M and the natural frequency reduces by 3Hz. Find the value of M and spring constant K. **(05 Marks)**

b. A vertical shaft of 100mm in diameter and 1m long has its upper end fixed at the top as shown in Fig.Q.8(b). At the other end it carries a disc of 500kg at a radius of gyration of 450mm. The modulus of rigidity and modulus of elasticity (Young's modulus) for the shaft material are 80GN/m^2 and 200GN/m^2 neglecting the weight of the shaft. Determine:
   i) Frequency of longitudinal vibration
   ii) Frequency of torsional vibration
   iii) Frequency of transverse vibration. **(15 Marks)**

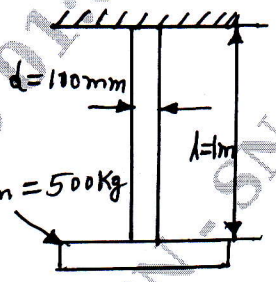

Fig.Q.8(b)

Module-5

9 a. Derive an expression for logarithmic decrement for an under damped case. **(10 Marks)**

b. Determine:
   i) Critical damping coefficient
   ii) Damping factor
   iii) Natural frequency of damped vibrations
   iv) Logarithmic decrement
   v) Ratio of two consecutive amplitudes of a vibrating system which consists of a mass of 25kg, a spring of stiffness 15kN/m and a damper. The damping provided is only 15% of the critical value. **(10 Marks)**

OR

10 a. Derive for transmissibility ratio due to harmonic excitation. **(10 Marks)**

b. A mass of 100kg been mounted a spring dashpot system having spring stiffness of 19,600N/m and damping coefficient of 100N-s/m. The mass is acted upon by a harmonic force of 39N at the undamped natural frequency of the system. Determine:
   i) Amplitude of vibration of the mass.
   ii) Phase difference between the force and displacement.
   iii) Forced transmissibility ratio. **(10 Marks)**

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