B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Fifth Semester

Mechanical Engineering

ME 2302/ME 52/ME 1301/10122 ME 503 — DYNAMICS OF MACHINERY

(Common to PTME 2302 — Dynamics of Machinery for B.E. (Part-time) Fourth Semester Mechanical Engineering Regulation 2009)

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A —.(10 x 2 = 20 marks)

1. What are the conditions for a body to be in equilibrium under the action of
   (a) Two forces and
   (b) Two forces and a torque?
2. What is meant by piston effort and crank effort?
3. Two masses in different planes are necessary to correct the dynamic unbalance - Justify.
4. Write a note on the effect of firing order on balancing of reciprocating mass in multi-cylinder IC engines.
5. A spring mass system has spring constant of 'k' and a mass of 'm'. It has a natural frequency of 12 c.p.s. If an additional mass of 2 kg is added to W, natural frequency reduces by 2 c.p.s. Find 'k' and 'm'.
6. What is meant by critically damped system? Give one application of critical damping.
7. A vibrating spring having a mass of 1 kg is suspended by a spring of stiffness 1000 N/m and its put to harmonic excitation of 10 N. Determine the resonant frequency and the amplitude of vibration at resonance.
8. List out the materials used for vibration isolation. Also which material is most suitable for compressive loads?
9. What is meant by applied torque and reaction torque?
10. Define sensitiveness of governor.

PART B — (5 x 16 = 80 marks)

11. (a) In a four link mechanism shown in Figure Q 11(a). Torque T_3 and T_4 have magnitudes of 30 Nm and 20 Nm respectively. The link lengths are AD = 800 mm, AB= 300 mm, BC= 700 mm and CD = 400 mm. For the static equilibrium of the mechanism determine the input torque T2. (16)

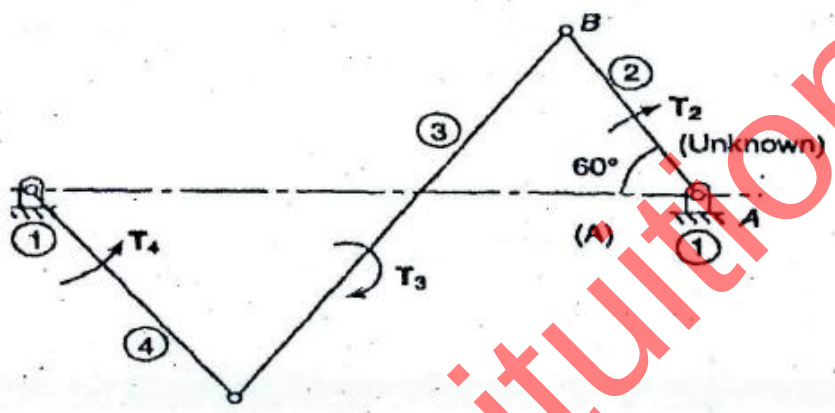


Figure Q. 11 (a)

Or

(b) (i) The turning moment diagram for a multicylinder engine has been drawn to a scale 1 mm= 600N-m vertically and 1 mm = 3° horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows: + 52, - 124, + 92, - 140, + 85, - 72 and + 107 mm^2, when the engine is running at a speed of 600 r.p.m. If the total fluctuation of speed is not to exceed ±1.5% of the mean, find the necessary mass of the flywheel of radius 0.5 m. (8)

(ii) A Punching press is driven by a constant torque electric motor. The press is provided with a flywheel that rotates at maximum speed of 225 rpm. The radius of gyration of the flywheel is 0.5 m. The press punches 720 holes per hour; each punching operation takes 2 seconds and requires 15 kN-m of energy. Find the Power of the motor and the minimum mass of the flywheel if speed of the same is not to fall below 200 r.p.m. (8)

12. (a) A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii of 80 mm, 70 mm, 60 mm and 80 mm in

planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitude and angular Position. (16)

Or

(b) The three cranks of a three Cylinder in-line IC engine are all on the same axle and their cranks are set to 120°. The pitch of the Cylinder is 1 m and the stroke of each piston is 0.6 m. The reciprocating masses are 300 kg for inside cylinder and 260 kg for each outside cylinder and the planes of rotation of the balance masses are 0.8 m from the inside crank. If 40 % of the reciprocating parts are to be balanced find the magnitude and the Position of the balancing masses required at a radius of 0.6 m and the hammer blow per wheel when the axle makes 6 r.p.s. (16)

13. (a) (i) A 5 kg mass attached to the lower end of a spring, whose upper end is fixed, vibrates with a natural period of 0.45 sec. Determine the natural period when 2.5 kg mass is attached to the midpoint of the same spring with the upper and lower ends fixed. (6)

(ii) A vibrating system is defined by the following parameters m = 3 kg, k = 100 N/m, C = 3 N-sec/m. Determine the damping factor, the natural frequency of damped vibration, logarithmic decrement, the ratio of two consecutive amplitudes and the number of cycles after which the original amplitude is reduced to 20 percent.(10)

Or

(b) (i) Derive the differential equation of motion for spring controlled simple pendulum as shown in figure Q 13 (b) (i). (8)

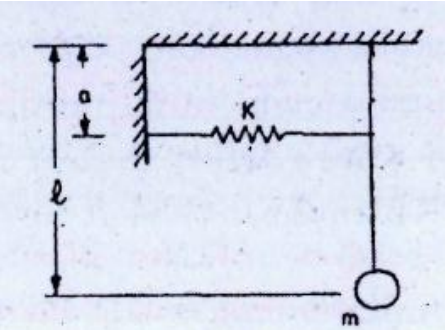


Figure Q 13 (b) (i)

(ii) A single rotor system has a natural frequency of 5 Hz. What length of steel rod of diameter 20 mm should be used for this rod? The inertia of the mass fixed at the free end is 0.0098 kg-m^2. Take G = 0.85 x 10^{11} N/m^2. (8)

14. (a) An electric motor is supported on a spring and a dashpot. The spring has a stiffness of 6400 N/m and the dashpot offers resistance of 500 N at 4 m/s. The unbalanced mass 0.5 kg rotates at 5 cm radius and the total mass of vibratory system is 20 kg. The motor runs at 400 rpm. Determine damping factor, amplitude of vibration and phase angle, resonant speed and resonant amplitude and force exerted by the spring and dashpot on the motor. (16)

Or

(b) A vibrating body is supported by six isolators each having stiffness of 32000 N/m and six dashpots having damping factor as 400 N-sec/m. The vibrating body is to be isolated by a rotating device having amplitude of 0.06 mm at 600 rpm. Take m = 30 kg. Determine the amplitude of vibration of the body and dynamic load on each isolator due to vibration. (16)

15. (a) In a Porter governor, each of the four arms is 400 mm long. The upper arms are pivoted on the axis of the sleeve; whereas the lower arms are attached to the sleeve at a distance of 45 mm from the axis of rotation. Each ball has a mass of 8 kg and the load on the sleeve is 60 kg. What will be the equilibrium speeds for the two extreme radius of 250 mm and 300 mm of rotation of the governor balls? (16)

Or

(b) A 2200 kg racing car has a wheel base of 2.4 m and a track of 1.4 m. The centre of mass of the car lies at 0.6 m above the ground and 1.4 m from the rear axle. Equivalent mass of engine parts is 140 kg with radius of gyration of 150 mm. The back axle ratio is

5. The engine shaft and flywheel rotate clockwise when viewed from the front. Each wheel has a diameter of 0.8 m and a moment of inertia of 0.7 kg m^2. Determine the load distribution on wheels when the car is rounding a curve of 100 m radius at a speed of 72 km/hr to the left turn and right turn. (16)

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2011.

Fifth Semester

Mechanical Engineering

ME 2302 — DYNAMICS OF MACHINERY

(Regulation 2008)

(Common to PTME 2302 - Dynamics of machinery for B.E. (Part-Time) Fourth Semester Mechanical Engineering Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 x 2 = 20 marks)

1. State D-Alembert's principle.
2. What is the purpose of flywheel? How do you differentiate the function of governor in engine with flywheel?
3. State the necessary conditions to achieve static balancing and dynamic balancing.
4. Reciprocating masses are partially balanced in a single cylinder engine -Justify.
5. A 0.25 kg mass is suspended by a spring having a stiffness of 0.1533 N/mm.Determine its natural frequency in cycles per second. Determine its static deflection.
6. What is meant by critical speed?
7. What is meant by forced vibration? Give some examples.
8. List out the sources of excitation in forced vibration.
9. What is meant by reactive gyroscopic couple?
10. Differentiate between stable governors and isochronous governors.

PART B — (5 x 16 = 80 marks)

11. (a) The crank and connecting rod of a petrol engine, running at 1800rpm are 50 mm and 200 mm respectively. The diameter of the piston is 80 mm and the mass of the reciprocating parts is 1 kg at a point during the power stroke, the pressure on the piston

is 0.7 N/mm^2, when it has moved 10 mm from the inner dead centre. Determine the net load on the gudgeon pin, thrust on the connecting rod, reaction between the piston and cylinder and the engine speed at which the above values become zero.

Or

(b) A three cylinder single acting engine has its cranks set equally at 120° and it runs at 600 r.p.m. The torque vs. crank angle diagram for each cycle is a triangle for the power stroke with a maximum torque of 90 N-m at 60° from dead centre of corresponding crank. The torque on return stroke is sensibly zero. Determine the power developed, co-efficient of fluctuation of speed, if the mass of the flywheel is 12 kg and a radius of gyration of 80 mm, co-efficient fluctuation of energy and maximum angular acceleration of the flywheel. (16)

12. (a) Four masses A, B, C and D as given below are to be balanced.

	A	B	C	D
Mass (Kg)	30	50	50	-
Radius (mm)	180	240	120	150

The planes containing masses B and C are 300 mm apart. The angle between planes containing B and C is 90°. B and C make angles of 210° and 120° respectively with D in the same sense. Find the magnitude and the angular positions of mass A and the position of planes A and D. (16)

Or

(b) The cranks and connecting rods of a four cylinder in-line engine running at 1800 rpm are 60 mm and 240 mm each respectively and the cylinders 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 of 1-4-2-3. The reciprocating mass corresponding to each cylinder is 1.5 kg. Determine the unbalanced primary and secondary forces, if any, and unbalanced primary and secondary couples with reference to central plane of the engine. (16)

13. (a) (i) A shaft 50 mm diameter and 3 meters long is simply supported at the ends and carries three point loads of 1000 N, 1500 N and 750 N at 1 m, 2 m and 2.5 m respectively from the left support. The Young's modulus for the shaft material is 200 GN/m^2. Find the frequency of transverse vibration. (8)

(ii) A vertical shaft of 5 mm diameter is 200 mm long and is supported in long bearings at its ends. A disc of mass 50 kg is attached to the centre of the shaft. Neglecting any increase in stiffness due to the attachment of the disc to the shaft, find the critical speed of rotation and the maximum bending stress when the shaft is rotating at 75% of the critical speed. The centre of the disc is 0.25 mm from the geometric axis of the shaft. Take E = 200 GN/m^2. (8)

Or

(b) (i) An instrument vibrates with a frequency of 1 Hz when there is no damping. When the damping is provided, the frequency of damped vibrations was observed to be 0.9 Hz. Find the damping factor and logarithmic decrement.

(ii) A 4-cylinder engine and flywheel coupled to a propeller are approximated to a 3

rotor system in which the engine is equivalent to a rotor of moment of inertia 800 kg-m^2, the fly wheel to a second rotor of 320 kg-m^2 and the propeller to a third rotor of 20 kg-m^2. The first and second rotors being connected by 50 mm diameter and 2 metre long shaft and the second and third rotors being connected by a 25 mm diameter and 2 metre long shaft. Neglecting the inertia of the shaft and taking its modulus of rigidity as 80 GN/m^2, determine the natural frequencies of torsional oscillations, and the position of the nodes.

14. (a) A machine of 100 kg mass is supported on a spring of stiffness 700 kN/m and has an unbalanced rotating element, which results in a disturbing force of 350 N at a speed of 3000 rpm. Assuming a damping factor of 0.20, determine its amplitude of motion due to unbalance, the transmissibility, and the transmitted force.

Or

(b) A machine of mass 1000 kg is acted upon by an external force of 2450 N at a frequency of 1500 rpm. To reduce the effects of vibration, isolator of rubber having static deflection of 2 mm under the machine load and an estimated damping of 0.2 are used. Determine the force transmitted to the foundation, the amplitude of vibration and the phase lag. (16)

15. (a) A spring loaded governor of the Hartnell type has arms of equal length. The masses rotate in a circle of 130 mm diameter when the sleeve is in the mid position and the ball arms are vertical. The equilibrium speed for this position is 450 rpm, neglecting friction. The maximum sleeve moment is to be 25 mm and the maximum variation of speed taking in account the friction to be 5 percent of the mid position speed. The mass of the sleeve is 4 kg and the friction may be considered equivalent to 30 N at the sleeve. The power of the governor must be sufficient to overcome the friction by 1% change of speed either way at mid-position. Determine, neglecting obliquity effect of arms;
(i) The value of each rotating mass (ii) The spring stiffness (iii) The initial compression of spring. (16)

Or

(b) A four wheeled motor car of mass 2000 kg has a wheel base 2.5 m, track width 1.5m and height of centre of gravity 500 mm above the ground level and lies at 1 m from the front axle. Each wheel has an effective diameter of 0.8 m and a moment of inertia of 0.8 kgf-m^2. The drive shaft, engine fly wheel and transmission are rotating at 4 times the speed of road wheel, in a clock wise direction when viewed from the front, and is equivalent to a mass of 75 kg having a radius of gyration of 100 mm.If the car is taking a right turn of 60 m radius at 60 km/h. find the load on each wheel. (16)

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2011

Fifth Semester

Mechanical Engineering

ME 2302 — DYNAMICS OF MACHINERY

(Regulation 2008)

(Common to PTME 2302 Dynamics of Machinery for B.E. (Part-Time) Mechanical Engineering Fourth Semester - Regulation 2009)

Time : Three hours Maximum : 100 marks

Answer ALL questions

PART A — (10 x 2 = 20 marks)

1. Write D'Alembert's principle. What is the use of it?
2. Differentiate between the usage of flywheel in engines and punching presses with turning moment diagrams.
3. How does firing order affect the balancing of inline multi cylinder engines?
4. Draw a sketch of pivoted cradle balancing machine with parts indicated.
5. A 5 kg mass attached to the lower end of a spring, whose upper end is fixed, vibrates with a natural period of 0.45 sec. Determine the stiffness of the spring.
6. A vibrating system has the following: m = 3 kg, k = 100 N/m and C = 3 N-sec/m. Determine the damping factor in the system.
7. Draw a graph showing the variation of amplitude transmissibility with respect to the variation in damping factor and frequency ratio.
8. A vibrating system having mass 1 kg is suspended by a spring of stiffness 1000 N/m and it is put to harmonic excitation of 10 N. Damping factor = 0.6. Determine the amplitude of vibration at resonance.
9. Define hunting and isochronism.
10. Write the equation for the stability of a two wheeler when it is taking a turn towards left or right.

PART B — (5 x 16 = 80 marks)

11. (a) The crank and the connecting rod of an engine are 125 mm and 500 mm

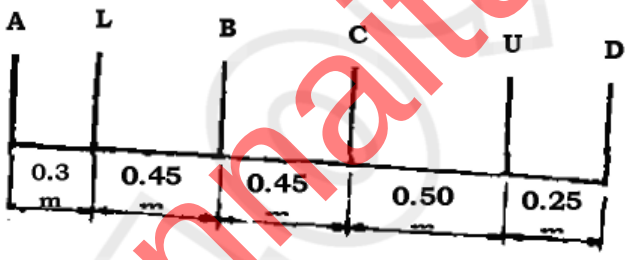
respectively. The mass of the connecting rod is 60 kg and its center of gravity is 275 mm from the cross head pin center. The radius of gyration about center of gravity being 150 mm. If the engine speed is 600 rpm for a crank position of 45 ° from the IDC, determine the acceleration of the piston and the magnitude, position and direction of inertia force due to the mass of the connecting rod.

Or

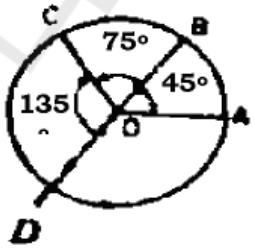
(b) A punching press is required to punch 30 mm diameter holes in a plate of 20 mm thickness at the rate of 20 holes/mm. It requires 6 Nm energy/mm^2 of sheared area. If punching takes places in 1/10 of a second and the speed of the flywheel varies from 160 to 140 rpm, determine the mass of the flywheel having radius of gyration 1 m.

12. (a) Determine the masses to be added at planes L and U at radii 0.6m if the system shown in Fig. is to be dynamically balanced. The unbalance mass and the eccentricities are given in the table below.

Plane	Mass (kg)	Eccentricity (m)
13.A	14.400	15.0.22
16.B	17.600	18.0.18
19.C	20.480	21.0.25
22.D	23.520	24.0.3



(i) Position of planes



(ii) Angular position.

(b) Crank and connecting rod of 4-cylinder in-line engine running at 1800 rpm are 60 mm and 240 mm respectively and the cylinders are spaced 150 mm apart. If the cylinders are numbered 1- 4 in sequence from one end, the cranks appear at intervals of 90° in an end view in the order 1-4-2-3. Reciprocating mass per cylinder is 1.5 kg. Find the unbalanced primary and secondary forces and unbalanced primary and secondary couples with reference to central plane of engine.

13. (a) A vibrating system consists of a mass of 20 kg, a spring of stiffness 20 kN/m

and a damper. The damping provided is only 30 % of the critical value. Determine the damping factor, critical damping coefficient, natural frequency of damped vibrations, logarithmic decrement and the ration of the consecutive amplitudes.

Or

(b) The flywheel of an engine driving a dynamo has a mass of 180 kg and a radius of gyration of 30 mm. The shaft at the flywheel end has an effective length of 250 mm and is 50mm in diameter. The armature mass is 120 kg and its radius of gyration is 22.5 mm. The dynamo shaft is 43 mm diameter and has 220 mm of effective length. Calculate the position of node frequency of torsional vibration.

14. (a) An electric motor is supported on a spring and a dashpot. The spring has the stiffness 6400 N/m and the dashpot offers resistance of 500 N at 4 m/sec. The unbalanced mass 0.5 kg rotates at 5 cm radius and the total mass of vibratory system is 20 kg. The motor runs at 400 rpm. Determine damping factor, amplitude of vibration, forces exerted by the spring and dashpot on the motor.

Or

(b) A vehicle weighs 490 kg and total spring constant of its suspension system is 300 N/cm. The profile of the road is approximated as SHM of amplitude 4 cm and wavelength of 4m. Determine the critical speed of the vehicle, the amplitude of the steady state motion of the mass when the vehicle is driven at critical speed when the damping factor is 0.5 and amplitude of the steady state motion when the vehicle is driven at 57 km/hr with same damping factor.

15. (a)The lengths of the upper and lower arms 200 mm and 250 mm respectively. Both the arms are pivoted on the axis of rotation. The central load is 150 N, the weight of each ball is 20 N and the friction of the sleeve together with the resistance of the operating gear is equivalent to a force of 30 N at the sleeve, If the limiting inclinations of the upper arms to the vertical are 28° and 38°, taking friction into account, find the range of speed of the governor.

Or

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

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2010

Fifth Semester

Mechanical Engineering

ME 2302 — DYNAMICS OF MACHINERY

(Regulation 2008)

Time : Three hours Maximum : 100 Marks

Answer ALL questions

PART A — (10 x 2 = 20 Marks)

1. Distinguish between crank effort and piston effort.
2. Define co-efficient of fluctuation of energy.
3. When is a system said to be completely balanced?
4. Name the efforts caused by the unbalanced primary force acting along the line of stroke due to partial balancing of locomotives.
5. Name the types of motion exhibited by critically damped or over damped vibrating systems.
6. Define logarithmic decrement.
7. Define transmissibility.
8. When does resonance take place in a system?
9. When is a governor said to be Isochronous?
10. When is a governor said to be stable?

PART B — (5 x 16 = 80 Marks)

11. (a) The lengths of crank and connecting rod of horizontal steam engine are 300 mm and 1.2 m respectively. When the crank has moved 30° from the inner dead center, the acceleration of piston is 35 m/s^2. The average frictional resistance to the motion of piston is equivalent to a force of 550 N and net effective steam pressure on piston is 500 kN/m^2. The diameter of piston is 0.3 m and mass of reciprocating parts is 160 kg. Determine (i) Reaction on the cross-head guides; (ii) Thrust on the crankshaft bearings; and (iii) Torque on the crank shaft.

Or

(b) The torque delivered by two-stroke engine is represented by T = (1000 + 300 sin 2θ) N.m Where θ is the angle turned by the crank from the inner-dead center. The engine speed is 250 rpm. The mass of the flywheel is 400 kg and radius of gyration 400 mm. Determine (i) the power developed; (ii) the total percentage fluctuation of speed; (iii) the angular acceleration of flywheel when the crank has rotated through an angle of 60° from the inner-dead center; and (iv) the maximum angular acceleration and retardation of the flywheel.

12. (a) A shaft carries four rotating masses A, B, C and D in this order along its axis. The mass of B, C and D are 30 kg, 50 kg and 40 kg respectively. The planes containing B and C are 30 cm apart. The angular spacing of the planes containing C and D are 90° and 210° respectively relative to B measured in the same sense. If the shaft and masses are to be in complete dynamic balance, find (i) the mass and the angular position of mass A; and (ii) the position of planes A and D.

Or

(b) The firing order in a 6 cylinder vertical four stroke engine in-line engine is 1-4-2-6-3-5. The piston stroke is 100 mm and the length of each connecting rod is 200 mm. The pitch distances between the cylinder center lines are 100 mm, 100 mm, 150 mm, 100 mm, and 100 mm respectively. The reciprocating mass per cylinder is 1 kg and the engine runs at 3000 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.

13. (a) Determine: (i) the critical damping co-efficient, (ii) the damping factor, (iii) the natural frequency of damped vibrations, (iv) the logarithmic decrement and (v) the ratio of two consecutive amplitudes of a vibrating system which consists of a mass of 25 kg, a spring of stiffness 15 kN/m and a damper. The damping provided is only 15% of the critical value.

Or

(b) A shaft of length 1.25 m is 75 mm in diameter for the first 275 mm of length, 125 mm in diameter for the next 500 mm length, 87.5 mm in diameter for the next 375 mm length and 175 mm in diameter for the remaining 100 mm of its length. The shaft carries two rotors at two ends. The mass moment of inertia of the first rotor is 75 kgm^2 where as of the second rotor is 50 kgm^2. Find the frequency of natural torsional vibrations of the system. The modulus of the rigidity of the shaft material may be taken as 80 GN/m^2.

14. (a)A body having a mass of 15 kg is suspended from a spring which deflects12 mm under weight of the mass. Determine the frequency of the free vibrations. What is the viscous damping force needed to make the motion a periodic at a speed of 1 mm/s? If, when damped to this extent, disturbing force having a maximum value of 100 N and vibrating at 6 Hz is made to act on the body, determine the amplitude of the ultimate motion.

Or

(b) A machine supported symmetrically on four springs has a mass of 80 kg. The mass of the reciprocating parts is 2.2 kg which move through a vertical stroke of 100 mm with simple harmonic motion. Neglecting damping, determine the combined stiffness of the springs so that the force transmitted to the foundation is l/20th of the impressed force. The machine crankshaft rotates at 800 rpm.

If, under actual working conditions, the damping reduces the amplitudes of successive vibrations by 30%, find: (i) the force transmitted to the foundation at 800 rpm, and (ii) the force transmitted to the foundation at resonance.

15. (a) The turbine rotor of a ship has a mass of 2.2 tonnes and rotates at 1800 rpm clockwise when viewed from the aft. The radius of gyration of the rotor is 320 mm. Determine the gyroscopic couple and its effect when (i) The ship turns right at a radius of 250 m with a speed of 25 km/h., (ii) The ship pitches with the bow rising at an angular velocity of 0.8 rad/s., and (iii) The ship rolls at an angular velocity of 0.1 rad/s.

Or

(b) The following particulars refer to a proell governor with open arms:

Length of all arms = 200 mm, distance of pivot of arms from the axis of rotation = 40 mm, length of extension of lower arms to which each ball is attached =100 mm, mass of each ball = 6kg and mass of the central load = 150 kg. If the radius of rotation of the balls is 180 mm when the arms are inclined at an angle of 40° to the axis of rotation, find the equilibrium speed for the above configuration.

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2010.

Fifth Semester

Mechanical Engineering

ME 1301 — DYNAMICS OF MACHINERY

(Common to Fourth Semester Mechatronics Engineering)

(Regulation 2004)

(Common to B.E. (Part-time) Fourth Semester-Regulation 2005)

Time : Three hours **Maximum : 100 marks**

Answer ALL questions.

PART A — (10 x 2 = 20 marks)

1. State the conditions to be satisfied in replacing dynamic analysis of a link by equivalent static problem.
2. Distinguish between radial cam and cylindrical cam.
3. Define tractive force in a two cylinder locomotive engine and state when it's magnitude is maximum and minimum.
4. Show the primary crank position and secondary crank position of a four cylinder in-line engine, power stroke of order 1-4-3-2.
5. Define whirling speed of a shaft.
6. Explain briefly the term "Logarithmic Decrement" as applied to damped vibrations.
7. Explain briefly the terms (a) dynamic magnifier and (b) transmissibiltty of vibrating systems.
8. Define torsionally equivalent shaft.
9. Derive an expression for the height in the case of a Watt governor.
10. What is the gyroscopic effect on a sea going vessels?

PART B — (5 x 16 = 80 marks)

11. (a) A connecting rod is suspended, from a point 25 mm above the centre of small end, and 650 mm above its centre of gravity, its mass being 37.5 kg. When permitted to oscillate, the time period is found to be 1.87 seconds. Find the dynamical equivalent system constituted of two masses,

one of which is located at the small end centre.

Or

(b) The crank pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C., the difference between the driving and back pressures is 0.35 N/mm2. The connecting rod length between centres is 1.2 m and the cylinder bore is 0.5 m. if the engine runs at 250 rpm and if the effect of piston rod diameter is neglected, calculate :

(i) pressure on slide bars
(ii) thrust in the connecting rod
(iii) tangential force on the crank-pin and
(iv) turning moment on the crank shaft.

12. (a) A shaft carries four masses in parallel planes, A, B, C and D in this order along its length. This masses at B and C are 18 kg and 21.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100° and that between the masses at B and A is 190°, both being measured in the same direction. The axial distance between the planes A and B is 100 m and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine :

(i) the magnitude of the masses at A and D ,
(ii) the distance between planes A and D and
(iii) the angular position of the mass at D.

Or

(b) The following data apply to an outside cylinder uncoupled locomotive :
Mass of a rotating parts per cyinder = 360 kg ; mass of reciprocating parts per cylinder = 300 kg ; angle between cranks = 90° ; crank radius = 0.3 m ; cylinder centres = 1.75 m ; radius of balance masses = 0.75 m ; wheel centres = 1.45 m. If whole of the rotating and two-thirds of reciprocating parts are to be balanced in planes of the driving wheels, find":

(i) magnitude and angular positions of balance masses.
(ii) speed in kilometers per hour at which the wheel will lift of the rails when the load on each driving wheel is 30 kN and the diameter of tread of driving wheels is 1.8 m, and
(iii) swaying couple at speed arrived at in (ii) above.

13. (a) A coil of spring stiffness 4 N/mm supports vertically a mass of 20 kg at the free end. The motion is resisted by the oil dashpot. It is found that the amplitude at the beginning of the fourth cycle is 0.8 times the amplitude of the previous vibration. Determine the damping force per unit velocity. Also find the ratio of the frequency of damped and undamped vibrations.

Or

(b) The two rotors A and B are attached to the end of a shaft 500 mm long.The mass of the rotor A is 300 kg and its radius of gyration is 300 mm. The corresponding values of the rotor B are 500 kg and 450 mm respectively. The shaft is 70 mm in diameter for the first 250 mm, 120 mm for the next 70 mm and 100 mm diameter for the remaining length. The modulus of rigidity for the shaft materials is 80 GN/m^2.

Find :

(i) the position of the node and
(ii) the frequency of torsional vibration.

14. (a) A mass of 10 kg is suspended from one end of a helical spring, the other end being fixed. The stiffness of the spring is 10 N/mm. The viscous damping causes the amplitude to decrease

to one-tenth of the initial . value in four complete oscillations. If a periodic force of 150 cos 50 t N is applied at the mass in the vertical direction, find the amplitude of the forced vibrations. What is its value of resonance?

Or

(b) A machine of mass 75 kg is mounted on springs of stiffness 1200 kN/m and with an assumed damping factor of 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 80 mm and a speed of 3000 cycles/min. Assuming the motion to be simple harmonic, find :

(i) the amplitude the motion of the machine
(ii) its phase angle with respect to the exciting force
(iii) the force transmitted to the foundation and
(iv) the phase angle of transmitted force with respect to the exciting force.

15. (a) In a spring loaded governor of the Hartnell type, the mass of each ball is 1 kg, length of vertical arm of the bell crank lever is 100 mm and that of the horizontal arm is 50 mm. The distance of fulcrum of each bell crank lever is 80 mm from the axis of rotation of the governor. The extreme radii of rotation of the balls are 75 mm and 112.5 mm. The maximum equilibrium speed is 5% greater than the minimum equilibrium speed which js 300 rpm. Find, neglecting obliquity of arms, initial compression of the spring equilibrium speed corresponding to the radius of rotation of 100 mm.

Or

(b) A ship propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 rpm. The rotor has a radius of gyration of 0.5 m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions :

(i) the ship sails at a speed of 30 km/h and steers to the left in a curve having 60 m radius.
(ii) the ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds.
(iii) the ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clockwise when viewed from stren.

Determine also the maximum angular acceleration during pitching. Explain how the direction of motion duo to gyroscopic effect is determined in each case.

B.E/B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.
Fifth Semester
. (Regulation 2004)
Mechanical Engineering
ME 1301 — DYNAMICS OF MACHINERY
(Common to Fourth Semester, Mechatronics Engineering)
(Common to B.E. (Part-Time) - Fourth Semester, Mechanical Engineering Regulation 2005)

Time : Three hours **Maximum : 100 marks**

Answer ALL questions.
PART A — (10 x 2 = 20 marks)

1. Define the significance of inertia force analysis.
2. Define D'Alemberts principle.
3. Differentiate: dynamic and static balancing.
4. Complete balancing of reciprocating mass in a single cylinder is not possible. Justify.
5. Define the term logarithmic decrement'.
6. Define damping factor.
7. Define transmissibility.
8. What is the need for vibration isolation?
9. Define hunting of the governor.
10. How does fly wheel differ from governor?

PART B — (5 x 16 = 80 marks)

11. (a) The turning moment diagram for a multi cylinder engine has been drawn to a scale of 1 mm = 325Nm vertically and l mm = 3° horizontally. The areas above and below the mean torque line are -26, +378, -256, +306, -302, +244, -380, +261 and -225 mm2 the engine is running at a mean speed of 600 rpm. The total fluctuation of speed is not to exceed ± 1.8% of the mean speed. If the radius of flywheel is 0.7 m, find the mass of the flywheel.

Or

(b) The dimensions of a four-link mechanism are AB = 500mm, BC = 660mm, CD = 560mm, and AD = 1000mm the link AB has an angular velocity of 10.5rad/s counter-clockwise and an angular retardation of 26rad/s2 at the instant when it makes an angle of 60° with AD, the fixed link. The mass of the links BC and CD is 4.2 kg/m length. The link AB has a mass of 3.54 kg, the center of which lies

at 200mm from A and a moment of inertia of 88,500 kgmm2 neglecting the gravity and friction effects, determine the instantaneous value of the drive torque required to be applied on AB to over come the inertia forces.

12. (a) A shaft is rotating at a uniform angular speed. Four masses m1, m2, m3 and m4 of magnitudes 300 kg, 450 kg, 360 kg, 390 kg respectively are attached rigidly to the shaft. The masses are rotating in the same plane. The corresponding radii of rotation are 200mm, 150mm, 250mm and 300mm, respectively. The angles made by these masses with horizontal are 0°, 45°, 120", and 255° respectively. If the system is to be balanced by adding two balancing mass. Find

(i) The magnitude of these balancing masses and

(ii) The position of the balancing mass if its radius of rotation is 200mm

Or

(b) (i)Derive the expressions for the following: (2x4 = 8)

(1) Variation in tractive force and

(2) Swaying couple.

(ii) The following data relate to a single cylinder vertical reciprocating engine; mass of reciprocating parts = 40kg, mass of revolving parts ss 30kg at 180mm radius, speed =150rpm, stroke 350mm. If 60% of the reciprocating parts and all the revolving parts are to be balanced, determine

(1) the balance mass required at a radius of 320 mm

(2) the unbalanced force when the crank has turned 45° from the top dead center.

13. (a) A shaft is simply supported at its ends and is of 40mm in diameter and 2.5m in length. The shaft carries three point loads of masses 30kg, 70kg, and 45kg, at 0.5m, lm, 1.7m respectively from the left support. The weight of the shaft per meter length is given as 73.575N. The young's modulus for the material of the shaft is 200GN/m2. Find the critical speed of the shaft.

Or

(b) A machine weighs 18 kg and is supported on spring and dashpots. The total stiffness of the springs is 12N/mm and damping coefficient is 0.2 N/mm/s. The system is imparted to the mass. Determine

(i) The displacement and velocity of mass as a function of time

(ii) The displacement and velocity after 0.4s.

14. (a) A machine supported symmetrically on four springs has a mass of 80 kg. The mass of the reciprocating parts is 2.2 kg which move through a vertical stroke of 100 mm with simple harmonic motion. Neglecting damping, determine the combined stiffness of the springs so that the force transmitted to the foundation is l/20th of the impressed force. The machine crankshaft rotates at 800 rpm.

If under actual working condition, the damping reduces the amplitudes of successive vibration by 30%, find

(i) the force transmitted to the foundation at 800rpm

(ii) the force transmitted to the foundation at resonance, and

(iii) the amplitude of the vibration at resonance.

Or

(b) A harmonic exciting force of 25N is acting on a machine part, which is having mass of 2 kg and is vibrating in a viscous medium. The exciting force causes resonant amplitude of 12.5mm with a period of 0.20 seconds. Determine the damping coefficient. If the system is excited by a

harmonic force of frequency 4Hz, find the increase in amplitude of forced vibration when damper is removed.

15. (a) A porter governor has all four arms 300mm long. The upper arms are pivoted on the axis of rotation and lower arms are attached to the sleeve at distance of 3.5 mm from the axis. The mass of each ball is 7 kg and the mass on the sleeve is 54 kg. If the extreme radii of rotation of the balls are 200mm and 250 mm, find the value of minimum speed.

Or

(b) The turbine rotator of a ship has a mass of 2200 kg and rotates at 1800 rpm clockwise when viewed from the Left the radius of gyration of the rotor is 320 mm find the gyroscopic couple and its effect when

(i) The ship turns right at radii of 250 m with a speed of 25 km/h
(ii) The ship pitches with bow rising at an angular velocity of 0.08 rad/s
(iii) The ship rolls at an angular velocity of 0.1 rad/s.

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009.
Fifth Semester
(Regulation 2004)
Mechanical Engineering
ME 1301 — DYNAMICS OF MACHINERY
(Common to B.E. —Part-Time-Fourth Semester -Regulation 2005)

Time: Three hours **Maximum: 100 marks**

Answer ALL questions.

PART A — (10 x 2 = 20 marks)

1. Explain free body diagram with one example.
2. What is engine shaking force?
3. Explain the term primary balancing and secondary balancing?
4. Explain the term 'Static Balancing' and 'Dynamic Balancing'.
5. What are the different types of vibratory motions?
6. What is the difference between 'viscous damping' and 'coulomb damping'?
7. Explain harmonic forcing.
8. Explain the terms: Vibration Isolation and Transmissibility.
9. What are centrifugal governor? How do they differ from inertia governors?
10. Explain what is meant by applied torque and reaction torque.

PART B — (5 x 16 = 80 marks)

11. (a) For static equilibrium of the mechanism of figure 1 ,find the required input torque. The dimensions are: AB = 150mm, BC = AD = 500mm, DC = 300mm, CE = 100mm and EF = 450mm.

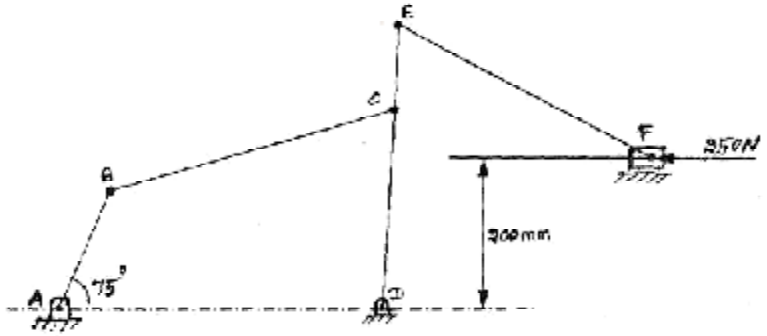


Figure 1.

Or

(b) The turning moment diagram for a multi cylinder engine has been drawn to a scale of lmm = 325 Nm vertically and lmm = 3° horizontally. The areas above and below the mean torque line are -26, +378, -256, +306, -302, +244, -380, +261 and -225 mm^2. The engine is running at a mean speed of 800 r.p.m. The total fluctuation of speed is not to exceed ±1.6% of the mean speed. If the radius of flywheel is 0.7 m, find the mass of the flywheel.

12. (a) A shaft carries four masses A, B, C and D of magnitude 200kg, 300kg, 400kg and 200kg respectively and revolving at radii 80mm, 70mm, 60mm and 80mm in planes measured from A at 300mm, 400mm and 700mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100mm, between X and Y is 400mm and between Y and D is 200mm. If the balancing masses revolve at a radius of 100mm, find their magnitudes and angular positions.

Or

(b) The cranks of a two cylinder uncoupled inside cylinder locomotive are at right angles and are 300mm long. The distance between the centre lines of the cylinder is 650mm. The wheel centre lines are 1.6m apart. The reciprocating mass per cylinder is 300kg. The driving wheel diameter is 1.8m. If the hammer blow is not to exceed 45kN at 100 km/hr, determine:

(i) the fraction of the reciprocating masses to be balanced
(ii) the variation in tractive effort
(iii) the maximum swaying couple

13. (a)(i)Derive an expression for the Natural frequency of Single Degrees of Freedom system.

(ii) Calculate the Whirling speed of a shaft 25mm.diameter and 0.7m long carrying a mass of 1 kg at its mid point. The density of the shaft material is 40000 kg/m^3, andE = 210GN/m^2. Assume the shaft to be freely supported.

Or

(b) The moment of inertia of three rotors A, B and C are respectively 0.3, 0.6 and 0.18 kg m^2. The distance between A and B is 1.5m and B and C is 1 m. the shaft is 70mm in diameter and the modulus of rigidity for the shaft material is 84 x 109 N/m^2. Find

(i) The frequencies of torsional vibrations,
(ii) Position of nodes and
(iii) amplitude of vibrations.

14. (a) A vibrating body is supported by six isolators each having stiffness 32000n/m and

6 dashpots having damping factor as 400 N-sec/m the vibrating body is to be isolated by a rotating device having an amplitude of 0.06mm at 600 rpm. Take m = 30kg.Determine

(i) Amplitude of vibration of the body

(ii) Dynamic load on each isolator due to vibration.

Or

(b) A machine supported symmetrically on four springs has a mass of 80 kg. The mass of the reciprocating part is 2.2kg which move through a vertical stroke of 100 mm with simple harmonic motion. Neglecting damping, determine the combined stiffness of the springs so that the force transmitted to the foundation is l/20th of the impressed force. The machine crankshaft rotates at 800rpm. If under actual working conditions, the damping reduces the amplitudes of successive vibrations by 30%, find,

(i) The force transmitted to the foundation at 800 rpm,

(ii) The force transmitted to the foundation at resonance, and

(iii) The amplitude of the vibrations at resonance.

15. (a) Calculate the range of speed of a porter governor which has equal arms of each 200mm long and pivoted on the axis of rotation. The mass of each ball is 4 kg and the central mass of the sleeve is 20kg. The radius of rotation of the balls is 100mm when the governor begins to lift and 130mm when the governor is at maximum speed.

Or

(b) Explain the gyroscopic effect on four wheeled vehicle.

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2008.

Fifth Semester

(Regulation 2004)

Mechanical Engineering

ME 1301 — DYNAMICS OF MACHINERY

(Common to B.E. (Part-Time) - Fourth Semester - Regulation 2005)

Time : Three hours **Maximum : 100 marks**

Answer ALL questions.

PART A — (10 x 2 = 20 marks)

1. Why flywheel is needed in a punching press?
2. Explain surge and windup.
3. Why rotating masses are to be dynamically balanced?
4. What is partial balancing? Why complete balancing of reciprocating masses is not possible in a single cylinder engine?
5. Which system is non vibratory in nature and comes to equilibrium in exponential manner?
6. Give an application of critical damping.
7. What is the value of the angular velocity (ω) such that natural frequency and time period are equal?
8. Define node in the case of vibration.
9. Define the meaning of stability of a governor.
10. What is gyroscopic torque?

PART B — (5 x 16 = 80 marks)

11. (a) The length of crank and connecting rod of a horizontal reciprocating engine are 200 mm and 1.0 m respectively. The crank is rotating at 400 r.p.m. When the crank has turned 30° from the inner dead centre, the difference of pressure between the cover end and piston end is 0.4 N/mm2. If the mass of the reciprocating parts is 100 kg and cylinder bore is 0.4 m, then calculate : (i) Inertia (ii) Force on piston (iii) Piston effort (iv) Thrust on the sides of cylinder walls (v) Thrust in the connecting rod.

Or

(b) A single cylinder, single acting, four stroke cycle gas engine develops 20 kW at 200 rpm. The work done by the gases during the expansion stroke is 3 times the work done on the gases during the compression stroke. The work done on the suction and exhaust strokes may be neglected. If the flywheelhas a mass of 1000 kg and has a radius of gyration of 0.6 m, find the cyclic fluctuation of energy and the co-efficient of fluctuation of speed.

12. (a) A two cylinder uncoupled locomotive has inside cylinders 0.6 m apart. The radius of each crank is 300 mm and are at right angles. The revolving mass per cylinder is 250 kg and the reciprocating mass per cylinder is 300 kg. The whole of the revolving and two third of reciprocating masses are to be balanced and the balanced masses are placed, in the planes of rotation of the driving wheels, at a radius of 1 m. The driving wheels are 2 m in diameter and 1.5 m apart. If the speed of the locomotive is 80 km/h. Find the hammer blow, maximum variation in tractive effort and maximum swaying couple.

Or

(b) Write short notes on :

(i) Balancing of machines and Balancing of linkages. (8)

(ii) Derive the expression for unbalanced reciprocating primary and secondary forces in a single cylinder engine, with usual notations. (8)

13. (a) A mass of 7.5 kg, hangs from a spring and makes damped oscillations. The time for 60 oscillations is 35 seconds and the ratio of the first and seventh displacement is 2.5. Find (i) the stiffness of the spring and (ii) the damping resistance in N/m/s. If the oscillations are critically damped, what is the damping resistance required in N/m/s?

Or

(b) The flywheel of an engine driving a dynamo has a mass of 180 kg and a radius of gyration of 30 mm. The shaft at the fly wheel end has an effective length of 250 mm and is 50 mm diameter. The armature mass is 120 kg and its radius of gyration is 22.5 mm. The dynamo shaft is 50 mm diameter and 200 mm effective length. Calculate the position of node and frequency of torsional oscillation. $C = 83\ kN/mm^2$.

14. (a) A machine of mass 75 kg is mounted on springs of stiffness 1200 kN/m and with an assumed damping factor of 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 80mm and a speed of 3000 cycles/min. Assuming the motion to be simple harmonic,

Find

(i) The amplitude of motion of the machine,

(ii) The phase angle with respect to the existing force,

(iii) The force transmitted to the foundation, and

(iv) The phase angle of transmitted force with respect to the exciting force.

Or

(b) A machine supported symmetrically on four springs has mass of 80 kg. The mass of the reciprocating parts is 2.2 kg which move through a vertical stroke of 100 mm with simple harmonic

motion. Neglecting damping, determine the combined, stiffness of the springs so that the force transmitted to the foundation is l/20th of the impressed force. The machine crankshaft rotates at 800 rpm.

If, under actual working conditions, the damping reduces the amplitudes of successive vibrations by 30% find :

(i) The force transmitted to the foundation at 800 rpm,

(ii) The force transmitted to the foundation at resonance, and

(iii) The amplitude of vibrations at resonance.

15. (a) The mass of each ball in a Wilson-Hartnell type of governor is 2.5 kg. The length of ball arm of each bell-crank lever is 100 mm where as the length of the sleeve arm of bell-crank lever is 80 mm. The minimum equilibrium speed is 200 rpm. When radius of rotation is 100 mm. When the sleeve is lifted by 8mm, the equilibrium speed is 212 rpm. The stiffness of each of the springs connected to the balls is 200 N/m. The lever for the auxiliary spring is pivoted at the midpoint. Find the stiffness of the auxiliary spring.

Or

(b) A ship is propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 rpm. The rotor has a radius of gyration of 0.5 m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions : The ship sails at a speed of 30 km/hr and steers to the left in a curve having 60 m radius. The ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds. The ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clockwise when viewed from stern. Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case.

B.E./B.Tech. DEGREE EXAMINATION, APRIUMAY 2008.

Fifth Semester

(Regulation 2004)

Mechanical Engineering

ME 1301 — DYNAMICS OF MACHINERY

(Common to RE. - Part-Time - Fourth Semester - Regulation 2005)

Time : Three hours **Maximum : 100 marks**

Answer ALL questions.

PART A — (10 x 2 = 20 marks)

1. Define angular velocity of precession.
2. Why single cylinder needs large size flywheel?
3. Mention any two methods to avoid derailment of the locomotive.
4. Compare the magnitude and direction of the unbalanced forces in the case of rotating masses and reciprocating masses.
5. What is the angle between excitation frequency and actual frequency at resonance?
6. Give an expression for inertia and damping force.
7. What is the role of transmissibility ratio?
8. Give an application of critical damping.
9. Define the meaning of stability of a governor.
10. Which part of the automobile is subjected to the gyroscopic couple?

PART B — (5 x 16 = 80 marks)

11. (a) A vertical double acting steam engine develops 75 kW at 250 r.p.m. The maximum

fluctuation of energy is 30 percent of the work done per stroke. The maximum and minimum speeds are not to vary more than 1 percent on either side of the mean speed. Find the mass of the flywheel required, if the radius of gyration is 0.6 m.

Or

(b) The length of crank and connecting rod of a vertical reciprocating engine are 300 mm and 1.5 m respectively. The crank is rotating at 200 rpm clockwise. Find analytically, (i) Acceleration of piston, (ii) velocity of piston (iii) angular acceleration of the connecting rod when the crank has turned through 40 degree from the top dead centre and the piston is moving downwards.

12. (a) A two cylinder uncoupled locomotive has inside cylinders 0.6 m apart. The radius of each crank is 300 mm and are at right angles. The revolving mass per cylinder is 250 kg and the reciprocating mass per cylinder is 300 kg. The whole of the revolving and two - third of reciprocating masses are to be balanced and the balanced masses are placed, in the planes of rotation of the driving wheels, at a radius of 0.8m. The driving wheels are 2 m in diameter and 1.5 m apart. If the speed of the engine is 80 km.p.h., find the hammer blow, maximum variation in tractive effort and maximum swaying couple.

Or

(b) A four cylinder engine has the two outer cranks at 120° to each other and their reciprocating masses are each 400 kg. The distance between the planes of rotation of adjacent cranks are 400 mm, 700 mm and 500 mm. Find the reciprocating mass and the relative angular position for each of the inner cranks, if the length of each crank is 350 mm, the length of each connecting rod 1.7m and the engine speed 500 r.p.m.

13. (a) A body of mass of 50 kg is supported by an elastic structure of stiffness 10 kN/m. The motion of the body is controlled by a dashpot such that the amplitude of vibration decreases to one-tenth of its original value after two complete cycles of vibration. Determine (i) the damping force at 1 m/s; (ii) the damping ratio; and (iii) the natural frequency of vibration.

Or

(b) Two parallel shafts A and B of diameters 50 mm and 70 mm respectively are connected by a pair of gear wheels, the speed of A being 4 times that of B. The mass moment of inertia of the flywheel is 3 kg-m2 is mounted on shaft A at a distance of 0.9 m from the gears. The shaft B also carries a flywheel of mass moment of inertia 16 kg-m2 at a distance of 0.6 m from the gears. Neglecting the effect of the shaft and gear masses, calculate the fundamental frequency of free torsional oscillations and the positions of node. Assume modulus of rigidity as 84 GN/m^2.

14. (a) A mass of 500 kg is mounted on supports having a total stiffness of 100 kN/m and which provides viscous damping, the damping ratio being 0.4. The mass is constrained to move vertically and is subjected to a vertical disturbing force of the type F cos ωt. Determine the frequency at which resonance will occur and the maximum allowable value of F if the amplitude at resonance is to be restricted to 5 mm.

Or

(b) A machine of mass 75 kg is mounted on springs of stiffness 1200 kN/m and with an assumed damping factor of 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 80 mm and a speed of 3000 cycles/min. Assuming the motion to be simple harmonic,

Find (i) the amplitude of motion of the machine, (ii) its phase angle with respect to the existing force, (iii) the force transmitted to the foundation, and (iv) the phase angle of transmitted force with respect to the exciting force.

15. (a) In a Porter governor, the mass of the central load is 18 kg and the mass of each ball is 2 kg. The top arms are 250 mm while the bottom arms are each 300 mm long. The fiction of the sleeve is 14 N. If the top arms make 45° with the axis of rotation in the equilibrium position, find the range of speed of the governor in that position.

Or

(b) A disk with radius of gyration 60 mm and a mass of 4 kg is mounted centrally on a horizontal axel. of 80 mm length between the bearings. It spins about the axle at 800 rpm counter-clockwise when viewed from the right-h'and side bearing. The axle precesses about vertical axis at 50 rpm in the clockwise directioI} when viewed from above. Determine the resultant reaction at each bearing due to the mass and gyroscopic effect.

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.
Fifth Semester
(Regulation 2004)
Mechanical Engineering
ME 1301 — DYNAMICS OF MACHINERY
(Common to B.E. Part-Time - Fourth Semester - Regulation 2005)

Time : Three hours **Maximum : 100 marks**

Answer ALL questions.

PART A — (10 x 2 = 20 marks)

1. Define D'Alembert's principle.
2. Define crank effort.
3. What is meant by balancing of rotating masses?
4. Define the term swaying couple.
5. What is meant by degrees of freedom in a vibrating system?
6. Define critical speed.
7. Define Magnification factor.
8. Explain the term 'vibration isolation'.
9. Write a note on 'Hunting of Governors'.
10. Write the expression for Gyroscopic Couple.

PART B — (5 x 16 = 80 marks)

11. (a) In a reciprocating engine mechanism, if the crank and the connecting rod are 300 mm and 1 m long respectively and the crank rotates at a constant speed of 200 r.p.m. Determine analytically,

(i) The crank angle at which the maximum velocity occurs and (3)

(ii) Maximum velocity of the piston. (3)

(iii) Derive the relevant equations. (10)

Or

(b) A vertical double acting steam engine has a cylinder 300 mm diameter and 450 mm stroke and runs at 200 r.p.m. The reciprocating parts has a mass of 225 kg and the piston rod is 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned through 125° from the top dead centre the steam pressure above the piston is 30 kN/m2 and below the piston is 1.5 kN/m2. Calculate

(i) Crank-pin effort and (12)

(ii) The effective turning moment on the crank shaft. (4)

12. (a) (i) Four masses ml'm2' m3 and m4 attached to a rotating shaft on the same plane are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45°, 75° and 135°. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m. (10)

(ii) Explain with neat sketches, balancing of a single revolving mass, by masses in two different planes in a rotating system. (6)

Or

(b) A four cylinder vertical engine has cranks 150 mm lvng. The planes of rotation of the first, second and fourth cranks are 400 mm, 200 mm and 200 mm respectively from the third crank and their reciprocating masses are 50 kg, 60 kg and 50 kg respectively. Find the mass of the reciprocating parts for the third cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance. (16)

13. (a) (i) A cantilever shaft 50 mm diameter and 300 mm long has a disc of mass 100 kg at its free end. The young's modulus for the shaft material is 200 GN/m2. Determine the frequency of longitudinal and transverse vibrations of the shaft. (10)

(ii) Explain with sketches different cases of damped vibrations. (6)

Or

(b) A steel shaft 1.5 m long is 95 mm in diameter for the first 0.6 m of its length, 60 mm in diameter for the next 0.5 m of the length and 50 mm in diameter for the remaining 0.4 m of its length. The shaft carries two flywheels at two ends, the first having a mass of 900 kg and 0.85 m radius of gyration located at the 95 mm diameter end and the second having mass of 700 kg and 0.55 m radius of gyration located at the order end. Determine the location of the node and the natural frequency of free torsional vibration of the system. The modulus of rigidity of shaft material may be taken as 80 GN/m2. (16)

14. (a) A mass of 10 kg is suspended from one end of a helical spring, the other end being fixed. The stiffness of the spring is 10 N/mm. The viscous damping causes the amplitude to decrease to one-tenth of the initial value in four complete oscillations. If a periodic force of 150 cos 50t N is applied at the mass in the vertical direction, find the amplitude of the forced vibrations. What is its value of resonance? (16)

Or

(b) The mass of an electric motor is 120 kg and it runs at 1500 r.p.m. The armature mass is 35 kg and its C.G. lies 0.5 mm from the axis of rotation. The motor is mounted on five springs of negligible damping so that the force transmitted is one-eleventh of the impressed force. Assume that

the mass of the motor is equally distributed among the five springs. Determine :

(i) Stiffness of each spring. (6)

(ii) Dynamic force transmitted to the base at the operating speed. (6)

(iii) Natural frequency of the system. (4)

15. (a) A porter governor has equal arms each 250 mm long and pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of the central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the minimum and maximum speeds and range of speed of the governor. (16)

Or

(b) (i) Explain the effect of Gyroscopic couple on a Naval ship during pitching. (8)

(ii) Explain the effect of Gyroscopic couple on a Aeroplane. (8)

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Fifth Semester

(Regulation 2004)

Mechanical Engineering

ME 1301 - DYNAMICS OF MACHINERY

(Common to B.E.(Part-Time)

Fourth Semester Regulation-2005)

Time : Three hours **Maximum : 100 marks**

Answer ALL questions.

PART A — (10 x 2 = 20 marks)

1. Why is balancing of rotating parts necessary for high speed engines?
2. Why do you want to find the natural frequency of rotating mass?
3. Why locomotive wheels need be coupled?
4. Why single cylinder engines are not fully balanced?
5. What are the effects of hammer blow and swaying couple?
6. Give an equation of damping factor.
7. What is the need for providing a fly wheel in a punching machine?
8. Define D'Alemberts principle.
9. Mention any four materials that arrest vibration.

10. What is the need for finding the critical speed of the shaft?

PART B — (5 x 16 = 80 marks)

11. (a) A single cylinder vertical engine has a bore of 30 cm and a stroke of 40 cm. The connecting rod is 100 cm long. The mass of the reciprocating parts is 140 kg. On the expansion stroke with the crank at 30° from the top dead centre the gas pressure is 0.7 MPa. If the engine runs at 250 rpm, find

(i) The net force acting on the piston
(ii) Resultant load on the gudgeon pin
(iii) Thrust on the cylinder walls
(iv) The speed above which things remaining same, the gudgeon pin load would be reversed in direction.

Or

(b) A punching press is required to punch 30 mm diameter holes in a plate of 20 mm thick at the rate of 20 holes/min. It requires 6 N -m of energy / mm^2 of sheared area. If punching takes place in 1/10 of a second and the rpm of the flywheel varies from 160 to 140; determine the weight of flywheel having radius of gyration K = 1 m.

12. (a) The camshaft a high speed pump consists of a parallel shaft 2.5 cm diameter and 48 cm long carries three eccentrics, each of diameter 6.0 cm and a uniform thickness of 1.8 cm. The assembly is symmetrical. The angle between the eccentrics is 120° and eccentricity is 1.25 cm. The material weighs of 0.007 kg/cm^3, and the speed of rotation is 1430 rpm. Find the dynamic load on each bearing due to out of balance couple. The distance between each eccentric is 8 cm from the centre of the shaft where the second eccentric is fixed. The distance between the bearings is 24 cm and symmetrically placed from the centre.

Or

(b) Prove that the resultant unbalanced force is minimum when half of the reciprocating masses are balanced by rotating masses.

13. (a) Calculate the natural frequency of a shaft diameter 10 cm and length 300 cm carrying two discs of diameters 125 cm and 200 cm respectively at its ends and weighing 480 kg and 900 kg respectively. Modulus of rigidity of the shaft is 2 x 10^6 kgf/cm^2 .

Or

(b) A body of 5 kg is supported on a spring of stiffness 200 N/m and has dashpot connected to it which produces a resistance of 0.002 N at a velocity of 1 cm/sec. In what ratio will the amplitude of vibration be reduced after 5 cycles?

4. (a) A vibratory body of mass 150 kg supported on springs of total stiffness 1050 kN/m has a rotating unbalance force of 525 N at a speed of 6000 rpm. If the damping factor is 0.3 find

(i) The amplitude caused by the unbalance
(ii) The transmissibility
(iii) The actual force transmitted and the phase angle.

Or

(b) A 1000 kg machine is mounted on four identical springs of total spring. Constant k and negligible damping. The machine is subjected to a harmonic external force of amplitude F = 490 N and frequency 180 rpm. Find the amplitude of the motion of machine and maximum force transmitted to the foundation, when k = 1.96 X 0^6 N/m.

15. (a) The marine turbine rotor of inertia 750 kgm^2 rotates at 3000 rpm clockwise when viewed from left. If the ship pitches with angular SHM with a period of 6 s and amplitude of 0.1 rad, find

(i) The maximum angular velocity of rotor
(ii) Maximum gyroscopic couple
(iii) Gyroscopic effect as the bow dips.

Or

(b) The upper arms of porter governor are pivoted on the axis of rotation, their lengths being 30 cm. The lower arms are pivoted on the sleeve at a distance of 3 cm from the axis, then lengths being 27 cm. Mass of each ball is 6 kg and the sleeve mass is 50 kg. Find the equilibrium speed for a radius of rotation of 17 cm and also the effort and power for *1%* change of speed.

B.E./ B.Tech DEGREE EXAMINATION, NOVEMBERIDECEMBER 2006.

Fifth Semester

Mechanical Engineering

ME 1301 — DYNAMICS OF MACHINERY

(Common to BE. Part-Time — Regulation 2005 — Fourth Semester)

(Regulation 2004)

Time : Three hours **Maximum : 100 marks**

Answer ALL questions.

PART A — (10 x 2 = 20 marks)

1. Why is flywheel necessary in a punching press?
2. Define crank effort and crank pin effort.
3. Distinguish between the unbalanced force caused due to rotating and reciprocating masses.
4. Why are the cranks of a locomotive, with two cylinders, placed at 90° to each other?
5. Sketch the, Time Vs Displacement plot for under damped and over damped systems.
6. Define logarithmic decrement.
7. What type of motion is exhibited by a vibrating system when it is critically damped?
8. Define Dynamic magnifier.
9. The engine of an aero plane rotates in clockwise direction when seen from the tail end and the aero plane takes a turn to the left. What will be the effect of gyroscopic couple on the aero plane?

10. When is a governor said to be "hunt"?

PART B — (5 x 16 = 80 marks)

11. (a) The variation of crankshaft torque of a four cylinder petrol engine may be approximately represented by taking the torque as zero for crank angles 0° and 180° and as 260 Nm for crank angles 20° and 45°, the intermediate portions of the torque graph being straight lines. The cycle is being repeated in every half revolution. The average speed is 600 rpm. Supposing that the engine drives a machine requiring constant torque, determine the mass of the flywheel of radius of gyration 250 mm, which must be provided so that the total variation of speed shall be one percent.

Or

(b) A single cylinder vertical engine has a bore of 300 mm and a stroke of 400 mm. The connecting rod is 1 m long and the mass of the reciprocating parts is 140 kg. On the expansion stroke, with the crank at 30° from the top dead center, the gas pressure is 0.7 MPa. If the engine runs at 250 rpm, determine (i) net force acting on the piston (ii) resultant load on the gudgeon pin (iii) thrust on the cylinder walls, and (iv) the speed above which, other things remaining the same, the gudgeon pin load would be reversed in direction.

12. (a) A shaft carries four rotating masses A, B, C and D which are completely balanced. The masses B, C and D are 50 kg, 80 kg and 70 kg respectively. The masses C and D make angles of 90° and 195° respectively with mass B in the same sense. The masses A, B, C and D are concentrated at radius 75 mm, 100 mm, 50 mm and 90 mm respectively. The plane of rotation of masses B and C are 250 mm apart. Determine (i) the magnitude of mass A and its angular position and (ii) the position of planes A and D.

Or

(b) The cranks of a two cylinder, uncoupled inside cylinder locomotive are at right angles and are 325 mm long. The cylinders are 675 mm apart. The rotating mass per cylinders are 200 kg at crank pin and the mass of the reciprocating parts per cylinder is 240 kg. The wheel center lines are 1.5 m apart. The whole of the rotating and two thirds of the reciprocating masses are to be balanced and the balance masses are to be placed in the planes of the rotation of the driving wheels at a radius of 800 mm. Find (i) the magnitude and direction of the balancing masses. (ii) the magnitude of hammer blow (iii) variation in tractive force and (iv) maximum swaying couple at a crank speed of 240 rpm..

13. (a) (i) A spring-mass system has spring stiffness of "k" N/m and a mass of "M" kg. It has the natural frequency of vibration as 12 Hz. An extra 2 kg mass is coupled to M and the natural frequency reduces by 2 Hz. Find the values of "k" and "M".

(ii) A steeped shaft is 0.05 m in diameter for the first 0.6 m length, 0.08 m diameter for the next 1.8 m and 0.03 m diameter for the remaining 0.25 m length. While the 0.05 m diameter end is fixed, the 0.03 m diameter end of the shaft carries a rotor of mass moment of inertia 14.7 kg-m^2. If the modulus of rigidity of the shaft material is 0.83 x 10^{11} N/m^2, find the natural frequency of torsional oscillations, neglecting the inertia effect of the shaft.

Or

(b) Between a solid mass of 10 kg and the floor are kept two slabs of isolators, natural rubber and felt, in series. The natural rubber slab has a stiffness of 3000 N/m and an equivalent viscous damping coefficient of 100 Nsec/m. The felt slab has a stiffness of 12000 N/m and equivalent viscous damping coefficient of 330 Nsec/m. Determine the undamped and the damped natural frequencies of the system in vertical direction, neglecting the mass of the isolators.

14. (a) A mass of 10 kg is suspended from one end of a helical spring, the other end being fixed. The stiffness of the spring is 10 N/mm. The viscous damping causes the amplitude to decrease to one tenth of the initial value in four complete oscillations. If a periodic force of 150 cos 50*t* N is applied at the mass in the vertical direction, find the amplitude of the forced vibrations. What is its value at resonance?

Or

(b) A machine supported symmetrically on four springs has a mass of 80 kg. The mass of the reciprocating parts is 2.2 kg which move through a vertical stroke of 100 mm with simple harmonic motion. Neglecting damping, determine the combined stiffness of the spring so that the force transmitted to foundation is 1/20th of the impressed force. The machine crank shaft rotates at 800 rpm. If under working conditions, the damping reduces the amplitudes of successive vibrations by 30%, find (i) the force transmitted to the foundation at resonance and (ii) the amplitude of vibration at resonance.

15. (a) A ship is propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 rpm. The rotor has a radius of gyration of 0.5 m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effect in the following conditions. (i) the ship sails at a speed of 30 km/hr and steers to the left in curve having 60 m radius. (ii) the ship pitches 6° above and 6° below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds. (iii) the ship rolls and at a certain instant it has an angular velocity of 0.03 rad/sec clockwise when viewed from stern.

Or

(b) The length of the upper and lower arms of a porter governor are 200 mm and 250 mm respectively. Both the arms are pivoted on the axis of rotation. The central load is 150 N, the weight of each ball is 20 N and ˜he friction on the sleeve together with the resistance of the operating gear is equivalent to a force of 30 N at the sleeve. If the limiting inclinations of the upper arms to the vertical are 30° and 40°, determine the range of speed of the governor.