Kadi Sarva Vishwavidyalaya

B.E. Sem VI (Mechanical Engineering)

Subject: Dynamics of Machinery (ME-602)

Date: 29/04/2015 Time: 3 Hrs Max. Marks: 70

Instructions:

(1) Answer each section in separate Answer sheet.
(2) Use of Scientific calculator is permitted.
(3) All questions are compulsory.
(4) Indicate clearly, the options you attempt along with its respective question number.
(5) Assume suitable data if necessary.
(6) Use the last page of main supplementary of rough work.

Section – I

Q.1

[A] Define the following terms:(i) Periodic motion (ii) Degree of Freedom (iii) Natural Frequency (iv) Damping Factor (v) Resonance [5]

[B] Find the natural frequency of vibration of system as shown in fig. 1. [5]

OR

[B] Find the natural frequency of a system shown in fig.2,Take K=1000 N/m, M =10 kg, m = 2 kg, R = 50 mm and r = 30 mm [5]

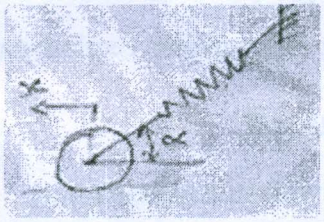

Fig.1

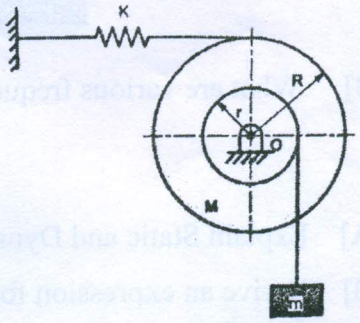

Fig.2

Q.2 [A] Explain coulomb damping and justify "the damping frequency is unaffected due to the addition of the damper." [5]

[B] The machine weighting 40 kg is supported on two slabs of isolators, natural rubber and felt as shown in fig.3. [5]

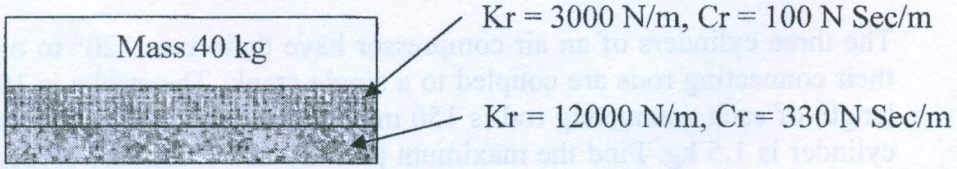

Fig.3

Determine undamped and damped natural frequencies of the system in vertical direction. Neglect the mass of the isolators.

OR

Q.2 [A] Two identical rotors are attached to the two ends of a stepped shaft. Moment of inertia of rotor on left side is 9 kgm^2 and on right side is 1 kgm^2. The diameter of shaft is 0.2 m for first 0.5 m length from left rotor. The diameter of shaft is 0.25 m for remaining length of 0.25 m. Determine the frequency of free Torsional vibration of the system, assume modulus of rigidity as 80×10^9 N/m^2. [6]

[B] Explain Vibration isolation and transmissibility with neat sketch. [4]

Q.3 [A] In a single degree viscously damped vibrating system, the suspended mass of 16 kg makes 45 oscillations in 27 seconds. The amplitude of natural vibration decreases to one fourth of initial value after 5 oscillations. Determine: [6]

(i) The logarithmic decrement.
(ii) The damping factor and damping coefficient.
(iii) The stiffness of the spring.

[B] Define logarithmic decrement and derive an expression for it. [4]

OR

Q.3 [A] The spring of an automobile trailer is compressed by 0.1 m under its own weight of 500 kg as shown in fig.4. Find the critical speed, when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude of 0.08 m and wave length of 14 m. What would be the amplitude if the trailer was to move at 60 km/hr. [6]

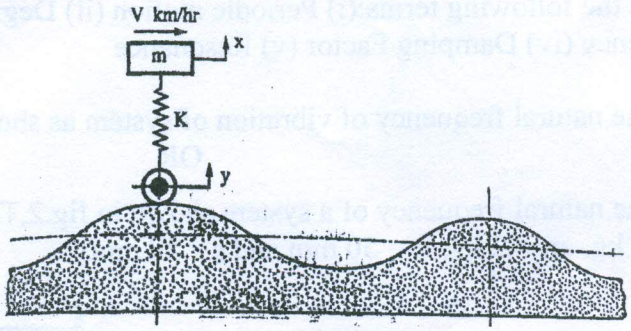

Fig.4

[B] What are various frequency measuring instruments? Explain any one in detail. [4]

Section – II

Q.4

[A] Explain Static and Dynamic balancing with suitable example. [5]

[B] Derive an expression for critical speed of a shaft carrying rotor and without damping. [5]

OR

[B] A shaft 50 mm diameter and 3 m long is simply supported at the ends carries three loads of 100 kg, 150 kg and 75 kg at 1 m, 2 m and 2.5 m from the left support. The modulus of elasticity of the shaft material is 2×10^5 MPa Find the critical speed of the shaft by using Dunkerley's method. [5]

Q.5 The three cylinders of an air compressor have their axes 120° to one another and their connecting rods are coupled to a single crank. The stroke is 100 mm and the length of each connecting rod is 150 mm. The mass of the reciprocating parts per cylinder is 1.5 kg. Find the maximum primary and secondary forces acting on the frame of the compressor when running at 3000 r.p.m. Describe clearly a method by which such forces may be balanced. [10]

OR

Q.5 The following data apply to an outside cylinder uncoupled locomotive : [10]
Mass of rotating parts per cylinder =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 :

1. Magnitude and angular positions of balance masses,
2. Speed in kilometres per hour at which the wheel will lift off the rails when the load on each driving wheel is 30 kN and the diameter of tread of driving wheels is 1.8m
3. Swaying couple at speed arrived at in (2) above.

Q.6 [A] A shaft with 3 metres span between two bearings carries two masses of 10 kg and 20 kg acting at the extremities of the arms 0.45 m and 0.6 m long respectively. The planes in which these masses rotate are 1.2 m and 2.4 m respectively from the left end bearing supporting the shaft. The angle between the arms is 60°. The speed of rotation of the shaft is 200 r.p.m. If the masses are balanced by two counter-masses rotating with the shaft acting at radii of 0.3 m and placed at 0.3 m from each bearing centres, estimate the magnitude of the two balance masses and their orientation with respect to the X-axis, i.e. mass of 10 kg. [7]

[B] Why is balancing of rotating parts necessary for high speed engines? [3]

OR

Q.6

[A] For an uncoupled two cylinder locomotive engine, derive the expressions of 'variation in tractive force', 'swaying couple' and 'hammer blow'. [6]

[B] Explain Primary unbalanced force in reciprocating engine. [4]

*******BEST OF LUCK*******

KADI SARVA VISHWAVIDYALAYA

B.E SEMESTER VI Theory EXAMINATION (November / 2015)

SUBJECT CODE: ME 602 SUBJECT NAME: Dynamics of Machinery

DATE: 02/11/2015 TIME: 2.00 p.m. to 5.00 p.m. TOTAL MARKS: 70

Instructions:

1. Answer each section in separate Answer Sheet.
2. Use of scientific Calculator is permitted.
3. All questions are compulsory.
4. Indicate **clearly**, the options you attempted along with its respective question number.
5. Use the last page of main supplementary for rough work.

Section - 1

Q:1 Answer the following Question. (All Compulsory)

(A) Justify the Sentence "Reciprocating masses are partially balanced." 05

(B) For an uncoupled two cylinder locomotive engine, derive the expressions of 'variation in tractive force', 'swaying couple' and 'hammer blow'. 05

(C) 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 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 magnitudes and angular positions. 05

OR

(C) A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 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 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine: 1. The magnitude of the masses at A and D; **2.** the distance between planes A and D ; and **3.** the angular position of the mass at D. 05

Q:2 Answer the following Question.

(A) Define Static and Dynamic balancing with suitable example. 05

(B) A shaft has three eccentrics, each 75 mm diameter and 25 mm thick, machined in one piece with the shaft. The central planes of the eccentric are 60 mm apart. The distance of the centres from the axis of rotation are 12 mm, 18 mm and 12 mm and their angular positions are 120° apart. The density of metal is 7000 kg/m3. Find the amount of out-of-balance force and couple at 600 r.p.m. If the shaft is balanced by adding two masses at a radius 75 mm and at distances of 100 mm from the central plane of the middle eccentric, find the amount of the masses and their angular positions. 05

OR

(A) Discuss the effects of partial balancing in locomotives. 05

(B) An inside cylinder locomotive has its cylinder centre lines 0.7 m apart and has a stroke of 0.6 m. The rotating masses per cylinder are equivalent to 150 kg at the crank pin, and the reciprocating masses per cylinder to 180 kg. The wheel centre lines are 1.5 m apart. The cranks are at right angles. The whole of the rotating and 2/3 of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Find the magnitude and direction of the balancing masses. Find the fluctuation in rail pressure under one wheel. 05

Q:3 Answer the following Question.

(A) Explain the method of direct and reverse cranks to determine the unbalance forces in radial engines. 05

(B) The following data refer to two cylinder locomotive with cranks at 90° : Reciprocating mass per cylinder = 300 kg ; Crank radius = 0.3 m ; Driving wheel diameter = 1.8 m ; Distance between cylinder centre lines = 0.65 m ; Distance between the driving wheel central planes = 1.55 m. Determine : 1.The fraction of the reciprocating masses to be balanced, if the hammer blow is not to exceed 46 kN at 96.5 km. p.h. 05

OR

(A) Explain the balancing of several masses rotating in different planes. 05

(B) A four cylinder vertical engine has cranks 150 mm long. 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. 05

Section - 2

Q:4 Answer the following Question. (All Compulsory)

(A) Define the following terms: 05

(i) Periodic motion (ii) Simple Harmonic Motion (iii) Degree of Freedom
(iv) Natural Frequency (v) Damping Factor

(B) Derive the expression to determine the natural frequency of free torsional vibrations of a 'geared system' in standard notations. 05

(C) A refrigerator unit having mass of 35 kg is to be supported on three springs, each having a spring stiffness *s*. the unit operates at 480 rpm. Find the value of stiffness *s* if only 10% of the shaking force is allowed to be transmitted to the supported. 05

OR

(C) A 30 kg weight of motor mounted on a damper which deflects by 2 mm due to motor weight. The weight of the rotor is 8 kg and has as eccentricity of 0.2 mm. the motor rotates at 1800 rpm. Find the amplitude of vibration of the motor and force transmitted to the foundation. 05

Q:5 Answer the following Question.

(A) What are various frequency measuring instruments? Explain any one in detail. 05

(B) 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. 05

OR

(A) Write the short note on 05
1. Torsionally equivalent shaft
2. Free torsional vibrations

(B) A machine of mass 100 kg is supported on an elastic support of total stiffness 800 kN/m and has rotating unbalanced element which results in disturbing force of 400 N at a speed of 3000 rpm. Assuming the damping ratio as 0.25, determine the amplitude of vibrations due to unbalance and the force transmitted to the support. 05

Q:6 Answer the following Question.

(A) Discuss the effect of inertia of constraint in longitudinal and transverse vibrations. 05

(B) shaft 50 mm diameter and 3 m long is simply supported at the ends carries three loads of 100 kg, 150 kg and 75 kg at 1 m, 2 m and 2.5 m from the left support. The modulus of elasticity of the shaft material is 2×105 MPa. Find the critical speed of the shaft by using Dunkerley's method.

OR

(A) Derive the governing equation characterizing the motion of free-damped system 05

(B) A vibrometer has a period of free vibration of 2 seconds. It is attached to a machine with a vertical harmonic frequency of 1 Hz. If the vibrometer mass has an amplitude of 2.5 mm relative to the vibrometer frame, what is the amplitude of vibration of machine? 05

-----All the Best --------