BITS PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
SECOND SEMESTER 2013-2014

COMPREHENSIVE EXAMINATION (Closed Book)

ME F343 MECHANICAL VIBRATIONS

Date: 27-05-2014 **Time: 3 hrs**
Marks: 80 **Weightage: 40%**

Note: 1. Answer all questions.
2. All questions carry equal marks.
3. Assume the data missing, if any, logically.
4. Answer part A and part B on separate Answer booklets.

PART A

Question 1

A vertical shaft 120 mm in diameter and 1.2 m in length has its upper end fixed at the top and at the other end carries a disc of weight 6 kN. The modulus of elasticity of the material of the shaft is 200GPa. Neglecting the weight of the shaft, determine the frequency of longitudinal and transverse vibrations. Draw the free hand sketches of the shaft in both the cases of vibrations. Take deflection of shaft under transverse vibration as $WL^3/3EI$.

Question 2

A machine of mass 12 kg is subjected on springs and dashpots. The total stiffness of springs is 6N/mm and total damping coefficient is 0.072 N/mm/s. The system is initially at rest and a velocity of 120mm/s is imparted to the mass. Determine the displacement and velocity after 2 sec.

Question 3

Derive an expression for displacement as a function of time for a over damped, under damped and critical damped free damped vibratory system with mass 'm', stiffness 'k' and damping coefficient 'c'. Draw free hand sketch showing clearly all the elements.

Question 4

A spring of stiffness 0.4 N/mm is attached to a mass which has a viscous damping device. When the mass is displaced and released, the period of vibration is 1.6 sec and the ratio of consecutive amplitude is 4:1. Determine the amplitude and phase angle when a force of $F= 3\sin 4t$ Newton acts on the system.

PART B

Question 5

Derive the mass, stiffness and viscous coefficient friction matrices for a 3-dof torsional system with 3 discs of mass moments of inertia J_1, J_2 and J_3 rotating in a viscous fluid of coefficient of friction f_1, f_2 and f_3 under discs 1, 2 and 3 respectively. Each disc is connected with the 3 shafts of stiffness k_1, k_2 and k_3 respectively with the first disc, connected with the fist shaft to the fixed end, Draw the free hand sketch showing the system and free body diagrams of all discs. Use Newton's laws of motion for deriving the matrices.

Question 6

Determine the eigen values of the 2 dof translational spring mass system with 2 masses m_1 and m_2 connected with two springs, each of stiffness k_1 and k_2 respectively with the fist mass connected to the fixed end with the first spring. Draw the normal modes of vibration to scale. Take $m_1 = 1$ kg, $m_2 = 2$ kg and $k_1 = k_2 = k_3 =$ 1500 N/m, Draw the free hand sketch of the system along with the free body diagrams.

Question 7

Draw the free hand sketch of 4 storey building and sketch the equivalent modeling diagram. Derive the stiffness matrix using stiffness influence coefficients by showing clearly the forces at each mass end.

Question 8

Find the matrix equation for a 3-dof spring mass system using Lagrange's equations. Draw the free hand sketch of 3-dof system with three masses m_1, m_2 and m_3 connected to 3 springs each of stiffness k_1, k_2 and k_3. The fist mass is connected to the fixed end with the first spring. Take $m_1 = 50$ kg, $m_2 = 25$ kg, $m_3 = 30$ kg and $k_1=k_2=k_3= 36$ kN/m.

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T E S T 2(Open Book)

ME C343 MECHANICAL VIBRATIONS

Date: 27-04-2014 Time: 50 minutes
Marks: 40 Weightage: 20%

Note: 1. Answer all questions.
2. Marks are shown in the brackets against each question.
3.Assume logically the missing data, if any
4 Prescribed text book and hand written notes are only allowed

Question 1
A spring of stiffness 0.3N/mm is attached to a mass which has viscous damping device. When the mass was displaced and released, the period of vibration was 0.8 sec and the ratio of amplitudes was 4.2:1. Determine amplitude and phase angle when a force of F= 2 sin 3t Newtons acts on the system. Draw the phase diagram showing all forces to scale. [20M]

Question 2
Draw the free hand sketch showing three masses m_1, m_2 and m_3 connected by 3 springs each of stiffness k_1, k_2 and k_3. Derive the equations of motion by drawing free body diagrams and find the mass and stiffness matrices. [10M]

Question 3
Draw the free hand sketch showing three discs of moments of inertia J_1, J_2 and J_3 connected by 3 rotors each of stiffness k_1, k_2 and k_3. Derive the equations of motion by drawing free body diagrams and find the mass and stiffness matrices. [10M]

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SECOND SEMESTER 2013-2014

T E S T 1(Closed Book)

ME C343 MECHANICAL VIBRATIONS

Date: 02-03-2014 **Time: 50 minutes**
Marks: 50 **Weightage: 25%**

Note: 1. Answer all questions.
2. Marks are shown in the brackets against each question.
3.Assume logically the missing data, if any

Question 1

(a) Derive the natural frequency of free vibration of a simple spring-mass system and deduce the values of maximum velocity and maximum acceleration. **[6M]**

(b) Draw the free hand sketches of single- dof, two-dof, 3-dof and infinite dof systems. **[4M]**

Question 2

(a) Define logarithmic decrement **[2M]**

(b) Derive an expression for logarithmic decrement by drawing a free hand sketch showing amplitude variation with respect to time. **[8M]**

Question 3

A vibrating system consists of a mass of 5 kg, a spring stiffness 4 N/mm and a dashpot with a damping coefficient of 13 N/m/s. Find the damping factor, natural frequency of damped system and the ratio of any two consecutive amplitudes. Derive the formulae used. **[10M]**

Question 4

(a) A mass of 0.3 kg is suspended by a spring of stiffness 016 N/mm. Determine its static deflection, natural frequency and time period of vibration. **[4M]**

(b) A simply supported shaft of 60 mm diameter and 0.4 m long has a disc of 120 kg-mass at its mid point. The modulus of elasticity of shaft material is 200 GPa. Determine the frequency of vibration of shaft. The deflection of shaft is given by $\delta = WL^3/48EI$, where **W** is the load at mid point, **L** is the length of the shaft. **[6M]**

Question 5

An automobile wheel and tire are suspended by a steel rod 6 mm in diameter and 1.6 m long. When the wheel is given an angular displacement and released, it makes 20 oscillations in one minute. If the shear modulus of steel is 80 GPa, find the polar moment of inertia of the wheel and tire. Draw the free hand sketch showing the system. **[10M]**

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ME C343 MECHANICAL VIBRATIONS
II SEMESTER 2013-2014
Q U I Z I

Max. Marks: 16 **Date: 23-03-2014**
Weightage: 8% **Duration: 20 Min.**

- **Answer all questions.**
- **Question no 1 to 4 carry 2 marks each and question no 5 and 5 carry 4 marks each.**
- **This question paper contains 2 pages.**

Question 1
Draw the free hand sketch of forced damped vibration with dashpot and spring.

Question 2
Define critical damping factor and write down its formula

Question 3
Draw the free hand sketch of phase diagram showing all forces for a forced damped vibratory system

Question 4
Write down the equations of motion for free damped and free undamped systems by drawing their free body diagrams..

Question 5
Find the damping factor of a system having a mass of 7 kg, a spring stiffness of 5 N/mm and a dashpot of coefficient 0.036 N/mm/s. Find also logartmic decrement and ratio of any 2 consecutive amplitudes.

Question 6
A harmonic force of 25 N acting on a machine part, having a mass of 3 kg is vibrating in a viscous medium. This force causes a natural frequency of 30 rad/s. Find the stiffness of the spring and amplitude of vibration at resonance.

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Q7 Find out the total acceleration of crank shaft of 100 mm length if it is rotating at an angular velocity of 2 rad/s in clock-wise direction and an angular acceleration of 1 rad/s^2 counter-clockwise direction.

Q8 Draw the free hand sketch of single slider crank mechanism of a horizontal reciprocating engine, by showing the directions of both radial and tangential components of acceleration of crankshaft on the free hand sketch(4 Marks)