BITS PILANI, DUBAI CAMPUS
III Year MECH
ME C422 DYNAMICS OF MACHINES & VIBRATIONS
II SEMESTER 2010-2011

COMPREHENSIVE EXAMINATION

Max. Marks: 80 **Duration: 3 Hrs.**
Weihtage:40% **Date: 08-06-2011**

- **Answer all questions.**
- **Marks are shown in brackets against each question.**
- **Draw suitable sketches for all questions.**
- **Assume missing data, if any, suitably.**

Question 1

(a) Derive an expression for angular acceleration of connecting rod of a horizontal reciprocating engine mechanism. **[2 M]**

(b) Draw Klein's velocity and acceleration diagrams for a slider mechanism, whose crank and connecting rod are 480 mm and 1600 mm long respectively.The crank rotates at a uniform angular velocity of 20 rad/s clock-wise. When the crank has turned 60^0 from the inner dead centre position determine the acceleration of connecting rod and acceleration of slider. **[8 M]**

Question 2

(a) What is meant by dynamically equivalent system and state the conditions for a dynamically equivalent system. **[4M]**

(b) The connecting rod of length between the two centres is 400 mm has a mass of 12 kg and the distance of its centre of gravity from the big end is 180 mm. The radius of gyration of the connecting rod is 150 mm about an axis through centre of gravity. If the connecting rod is replaced by two masses located at the two centres, find the masses and correction couple that must be applied for complete dynamical equivalence of the system, when the angular acceleration of the connecting rod is 120 rad/s^2 clock-wise. **[6M]**

Question 3

(a) The length of the connecting rod of a vertical double acting steam engine is 1.6m. The diameter of cylinder is 420 mm and stroke of the engine is 600 mm. The crank is rotating at 200 rpm in the clock-wise direction. The crank has turned through 35^0 from the top dead centre and piston is moving downwards.
The steam pressure above and below the piston are 0.6 N/mm^2 and 0.06N/mm^2 respectively. The mass of the reciprocating parts is 220 kg and the diameter of piston rod is 40 mm. Fin the Piston effort and crankpin effort. **[6M]**

(b) Derive the above expressions used in the inertia force analysis of steam engine Mechanism. **[4M]**

Question 4

(a) The turning moment diagram of for a multi-cylinder engine has been drawn to a vertical scale of 1mm = 320 Nm and a horizontal scale of 1 mm = 45^0. The areas above and below the mean torque line are -30, +382, -262, +312, -302, +244, -380, +267 and -221 mm^2. The fluctuation of speed is limited to 1.8% of mean speed which is 260 rpm. Determine a suitable diameter and cross-section of the fly wheel rim for a limiting value of the safe centrifugal stress of 5 N/mm^2. The density of the rim material may be assumed as 7200 kg/m^3. Design the flywheel. **[8M]**

(b) Explain briefly in what way flywheel is different from governor. **[2M]**

Question 5

(a) Four masses A, B,C and D are attached to a rotating shaft with radii 50 mm, 65 mm, 100 mm and 75 mm respectively. The distances between planes A and B; between planes B and C; between planes C and D are 500 mm each. Find the balancing masses B and D if the masses A and C are14 kg and 10 kg respectively. **[8M]**

(b) Explain the effects of partial balancing of locomotives. **[2M]**

Question 6

(a) A ship has a turbine rotor of mass 5 tonnes and radius of gyration 500 mm. It rotates at 1300 rpm in clock-wise sense when looking from the stern. Determine the gyroscopic couple under the following conditions:

(i) The ship steers to the left at a radius of 120 m with a speed of 2.2 km/hr.

(ii) The ship pitches with SHM with amplitude of 9 degrees and time periods 14 sec. **[6M]**

(b)Derive the expressions for gyroscopic couple for a ship during steering, pitching and rolling. **[4M]**

Question 7

(a) Derive an expression used for finding the time period of oscillation of the shaft subjecte to longitudinal vibration and find the natural frequency of this shaft which is of 20 mm diameter and of length 6m. The shaft carries a load of 10 N at its end. Take Young's modulus of the material of the shaft is 200 GN/m^2. **[5M]**

(b) Explain briefly logarithmic decrement and determine logarithmic decrement for a vibrating system, which consists of mass of 4 kg, a spring of stiffness 3 N/mm and damper of damping coefficient 0.024 N/mm/s. **[5M]**

Question 8

(a) A simply supported shaft of length 820 mm carries a mass of 50 kg placed 300 mm from its Left end. Find its natural frequency of vibration if its modulus of elasticity is 200 GPa and diameter of shaft is 45 mm. Derive the expression used. **[5M]**

(b) Find the damping factor of a vibrating system which consists of 4 kg mass, a spring of stiffness 3 N/mm and a damping coefficient of 0.021N/mm/s. What is the period of damped vibration? **[5M]**

BITS PILANI, DUBAI CAMPUS
ME C422 DYNAMICS OF MACHINES & VIBRATIONS
II SEMESTER 2010-2011

T E S T II
(OPEN BOOK)

Max. Marks: 20 **Duration: 50 Min.**
Date: 01-05-2011

NOTE:

- **Answer all questions.**
- **You are allowed to use prescribed text book and hand-written class notes only.**
- **Assume suitably missing data if any.**
- **Draw free hand sketches for all questions.**
- **Marks are shown in brackets against each question.**

Question 1

The length of crankshaft and connecting rod of a vertical four stroke engine are 100 mm and 250 mm respectively. ~~The crank shaft is rotating at 450 TDC~~. Find the masses at the ends of connecting rod and its equivalent length if the distance of centre of gravity of connecting rod of 2 kg mass from big end is 150 mm and radius of gyration about its cenroidal axis is 40 mm. **[3 M]**

Question 2

A small connecting rod 200 mm long between centres has a mass of 3 kg and moment of inertia of 0.03 kg.m^2 about its centre of gravity, which is located at a distance of 130 mm from the small end centre. If the connecting rod is to be replaced by 2 masses, find the correction couple to be applied for a complete dynamically equivalent system. Take angular acceleration of connecting rod as 22,000 rad/s^2. **[5M]**

Question 3

The turning moment diagram of for a multi-cylinder engine has been drawn to a vertical scale of 1mm = 325 Nm and a horizontal scale of 1 mm = 4.5^0. The areas above and below the mean torque line are -30, +382, -262, +312, -302, +244, -380, +267 and -231 mm^2. The fluctuation of speed is limited to 1.8% of mean speed which is 300 rpm. Determine a suitable diameter and cross-section of the fly wheel rim for a limiting value of the safe centrifugal stress of 6 N/mm^2. The density of the rim material may be assumed as 7000 kg/m^3. **[6M]**

Question 4

A disturbing mass 500 kg is attached to a shaft rotating at 300 rpm and its centre of gravity is at a distance of 280 mm from the axis of rotation. This mass is to be balanced by 2 masses which should be placed in different planes on either side of the disturbing mass. The distances of the centre of gravity of the balancing masses from the axis of rotation are 400 mm each. The distance between the disturbing plane and one of the balancing planes is 300 mm and the distance between the 2 balancing planes is 1.6 m. Determine the magnitude of balancing masses and the distance between the disturbing plane and the second balancing plane. **[6M]**

BITS PILANI, DUBAI CAMPUS
III Year MECHANICAL
ME C422 DYNAMICS OF MACHINES & VIBRATIONS
II SEMESTER 2010-2011

T E S T 1 (Closed Book)

Max. Marks: 25 **Duration: 50 minutes**
Weightage: 25% **Date: 10-03-2011**

- **Answer all questions.**
- **Marks are shown in brackets against each question.**
- **Draw suitable sketches, wherever necessary.**
- **Assume missing data if any suitably.**

Question 1

(a) Define degree of freedom and mention degrees of freedom for various planar kinematic pairs with suitable sketches. **[3 M]**

(b) Find the magnitude and direction of total acceleration for a slider on a slotted lever, which is at a distance of 0.5 m from the fixed point. The slider is sliding at 2 m/s velocity and 3 m/s^2 in the outward direction. The slotted lever is rotating at 1 rad/s (clock-wise) and 0.5 rad/s^2 (counter clockwise). **[4 M]**

Question 2

The lengths of the crank and connecting rod of a reciprocating engine are 250 mm and 750 mm respectively. The crank shaft is rotating at a uniform speed of 500 r.p.m. Using Klein's construction, draw the velocity and acceleration diagrams and find the velocity and acceleration of the piston. The crank is turning through 40^0 from inner dead centre. **[8 M]**

Question 3

The length of the connecting rod of a vertical double acting steam engine is 1.5m. The diameter of cylinder is 400 mm and stroke of the engine is 500 mm. The crank is rotating at 200 rpm in the clock-wise direction. The crank has turned through 45^0 from the top dead centre and piston is accelerating at 5 m/s^2. The steam pressure above and below the piston are 0.6 N/mm^2 and 0.06 N/mm^2 respectively. The mass of the reciprocating parts is 220 kg and the diameter of piston rod is 40 mm. Draw the free hand sketch of reciprocating engine mechanism, showing all the forces. Fin the Piston effort, crankpin effort, thrust on cylinder walls and torque on crank shaft. **[10M]**

NAME:_____

ID NO:_____

B

BITS PILANI, DUBAI CAMPUS
ME C422 DYNAMICS OF MACHINES & VIBRATIONS
II SEMESTER 2010-2011

Q U I Z II

Max. Marks: 07 **Duration: 20 Min.**
Weightage: 7% **Date: 18-05-2011**

- **Answer all questions.**
- **Put √ mark in the brackets provided against the suitable answer for the questions in PART I and Solve the problems in PART II**
- **Marks are shown in brackets against each question.**

P A R T I

Question1 Balancing is necessary to prevent **[1/2 M]**

A static forces [ ]

B dynamic forces [ ]

C gravity forces [ ]

D None of the above [ ]

Question 2 If a single mass can be balanced by two masses in different planes, then
i) centrifugal force on one balancing mass will be in the same direction and on another balancing mass will be opposite to that on the disturbing mass

ii) centrifugal forces on both the balancing masses and disturbing mass will be in the same direction **[1/2 M]**

A Both i) and ii) are true [ ]

B Both i) and ii) are false [ ]

C i) is true and ii) is false [ ]

D i) is false and ii) is true [ ]

Question 6 Find the damping ratio of a vibrating system of 4 kg mass, a spring of stiffness of 2 N/mm and a damper of damping coefficient 0.02 N s/mm. **[2M]**

Question 7 Find the logarithmic decrement of a vibrating system, which consists of 2.5 kg mass, a spring stiffness of 3 N/mm and a damper of damping coefficient 0.018 N s/mm. **[2M]**

NAME:_____ **A**

ID NO:_____

BITS PILANI, DUBAI CAMPUS
ME C422 DYNAMICS OF MACHINES & VIBRATIONS
II SEMESTER 20010-2011

Q U I Z I

Max. Marks: 08 **Duration: 20 Min.**
Date: 06-04-2011

- **Answer all questions.**
- **Put √ mark in the brackets provided against the suitable answer for the first 4 questions.**
- **Marks are shown in brackets against each question.**
- **No extra sheets will be provided. Solution should be given in the space provided below for the last 3 questions.**

Question 1
Crank pin effort acts **[½ M]**

A Parallel to the line of stroke. [ ]

B Perpendicular to the line of stroke. [ ]

C Parallel to the connecting rod. [ ]

D Perpendicular to the crank shaft. [ ]

Question 2
For a dynamically equivalent rigid body, its radius of gyration about the centroidal axis is **[½ M]**

A Geometric mean of the distances of two masses from the centre of gravity. [ ]

B Harmonic mean of the distances of two masses from the centre of gravity. [ ]

C Arithmetic mean of the distances of two masses from the centre of gravity. [ ]

D Mean of the radii of gyration of two masses. [ ]

Question 3

Which of the following is not the condition for a dynamically equivalent Sysem? [½ M]

A Mass of the rigid body is equal to the sum of the two masses at its ends. [ ]

B The moments of the two masses about the centre of gravity of rigid body must be equal. [ ]

C The radii of gyration of rigid body about its centre of gravity must be equal to the sum of radii of gyration of two masses. [ ]

D The moment of inertia of the rigid body about its centre of gravity Must be equal to the sum of moments of inertia of the two masses. [ ]

Question 4

Which of the following is considered as a dynamically equivalent system for finding the actual torque on crank shaft? [½ M]

A Piston [ ]

B Crank shaft [ ]

C Connecting rod [ ]

D Cylinder [ ]

Question 5

The angle and radius of crank shaft are 30^0 and 100 mm respectively. If the correcting force at the crank pin is 90 N, then find correcting torque on the crank shaft. **[2M]**

Question6

The length of the stroke of an engine is 500 mm. If the crank pin effort is 120 kN, then find the approximate on the crank shaft i **[2M]**

Question 7

The connecting rod has a radius of gyration about it centriodal axis is 625 mm. Find the equivalent length of connecting rod if one of the masses is at a distance of 1 m from its centre of gravity. **[2M]**