BITS PILANI, DUBAI CAMPUS
III Year MECH
ME C422 DYNAMICS OF MACHINES & VIBRATIONS
II SEMESTER 2011-2012

Comprehensive Examination (Closed Book)

Max. Marks: 80 **Duration: 3 Hrs.**
Weightage: 40% **Date: 10-06-2012**

- **Answer all questions.**
- **Marks are shown in brackets against each question.**
- **Draw suitable sketches, wherever necessary.**
- **Assume missing data, if any suitably.**
- **This question paper consists of 2 pages.**

Question 1

The crank shaft of a horizontal reciprocating engine is rotating clock-wise direction with a constant angular velocity of 60 rad/s. The lengths of crank and connecting rod are 100 mm and 350 mm respectively. Find the velocities and acceleration of crank shaft, connecting rod and piston when the crank has turned through 30^0 from inner dead centre. Use Klein's construction only. **[10M]**

Question 2

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 0.06 $/mm^2$ respectively. The mass of the reciprocating parts is 220 kg and the diameter of piston rod is 40 mm. Find the Piston effort and crankpin effort. **[10M]**

Question 3

The connecting rod of length between the two centres is 500 mm has a mass of 15 kg and the distance of its centre of gravity from the big end is 200 mm. The radius of gyration of the connecting rod is 140 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 150 rad/s^2 clock-wise. Find also the actual turning moment on crankshaft. **[10M]**

Question 4

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. The width of the rim is 4.5 times its thickness. Neglect the effect of the boss and arms. **[10M]**

Question 5

The lengths of 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 friction of the sleeve is equivalent to a force of 30 N at the sleeve. If the limiting inclinations of upper arms to the vertical are 30^0 and 40^0, determine the range of speed. of governor. **[10M]**

Question 6

A disturbing mass 600 kg is attached to a shaft rotating at 200 rpm and its centre of gravity is at a distance of 250 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 350 mm each. The distance between the disturbing plane and one of the balancing planes is 280 mm and the distance between the 2 balancing planes is 1.5 m. Determine the magnitude of balancing masses and the distance between the disturbing plane and the second balancing plane. **[10M]**

Question 7

A ship has a turbine rotor of mass 5 tonnes and radius of gyration 600 mm. It rotates at 1500 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 100 m with a speed of 2 km/hr.

(ii)The ship pitches with SHM with amplitude of 8 degrees and time periods 12 sec.

(iii)The ship rolls in the sea. **[10M]**

Question 8

(a) Derive the equation of motion for a spring-mass system and find the displacement if its initial displacement and velocity are 1m and 2 m/s respectively. The vibrating system consists of mass of 3.5 kg, a spring of stiffness 2.5 N/mm . Find also time period and frequency of vibration. **[5M]**

(b) Derive an expression for longitudinal vibration of a vertical shaft, 2 m long and 50 mm diameter with **a** modulus of elasticity of material of the shaft as 200 GPa. It carries 5 kg mass at its free end. The shaft is fixed at the top end and neglect the mass of the shaft. Find its frequency of longitudinal vibration. **[5M]**

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T E S T II (OPEN BOOK)

ME C422 Dynamics of Machines and Vibrations

Date: 06-05-20012 **Time: 50 minutes**
Marks: 20 **Weightage: 20%**
Note: 1. Answer all questions.
2. Marks are shown in the brackets against each question.
3. Prescribed Text Book and hand-written class notes are only allowed.
4. Assume logically missing data, if any

Question 1
The crank of a reciprocating engine is rotating in clock-wise direction with a constant angular velocity of 30 rad/s. The length of crank and connecting rod are 200 mm and 750 mm respectively. Using Klein's construction, find velocity of piston, acceleration of piston when the crank has turned through 40^0 from TDC. The construction should be drawing to a scale. [3M]

Question 2
A horizontal Steam engine has a crank radius of length 150 mm and connecting rod of 750 mm length. Find analytically the displacement, velocity and acceleration of piston when the crank rotates at a constant speed of 300 rpm and is turned through an angle of 30^0.Draw the freehand sketch of the mechanism. [8M]

Question 3
The lengths of crank and connecting rod of a horizontal steam engine are 300mm and 1.2 m respectively. When the crank has turned 40^0 from IDC, the acceleration of piston is 30 m/s^2. The frictional force is 500 N and effective stem pressure on piston is 500 kPa. The cylinder bore is 0.3 m and mass of reciprocating parts is 150 kg. Determine thrust on cylinder walls, thrust on bearings and approximate torque on crank shaft. Draw free hand sketch, showing all forces. [5M]

Question 4
A small connecting rod 250 mm long between centres has a mass of 3 kg and moment of inertia of 20,000 kg mm^2 about its centre of gravity.Centre of gravity is situated at a distance of 150 mm from the small end centre. Determine the dynamically equivalent 2- mass system when one mass is situated at the small end centre.

If the connecting rod is replaced by this 2-mass system, find the correction in couple that must be applied for a complete dynamical equivalence of the system, when the angular acceleration of connecting rod is 22,000 rad/s^2 clock-wise. Draw free hand sketch of the equivalent and original system. [4M]

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S ECOND SEMESTER 2011-2012

T E S T I

DE G611 Dynamics and Vibrations

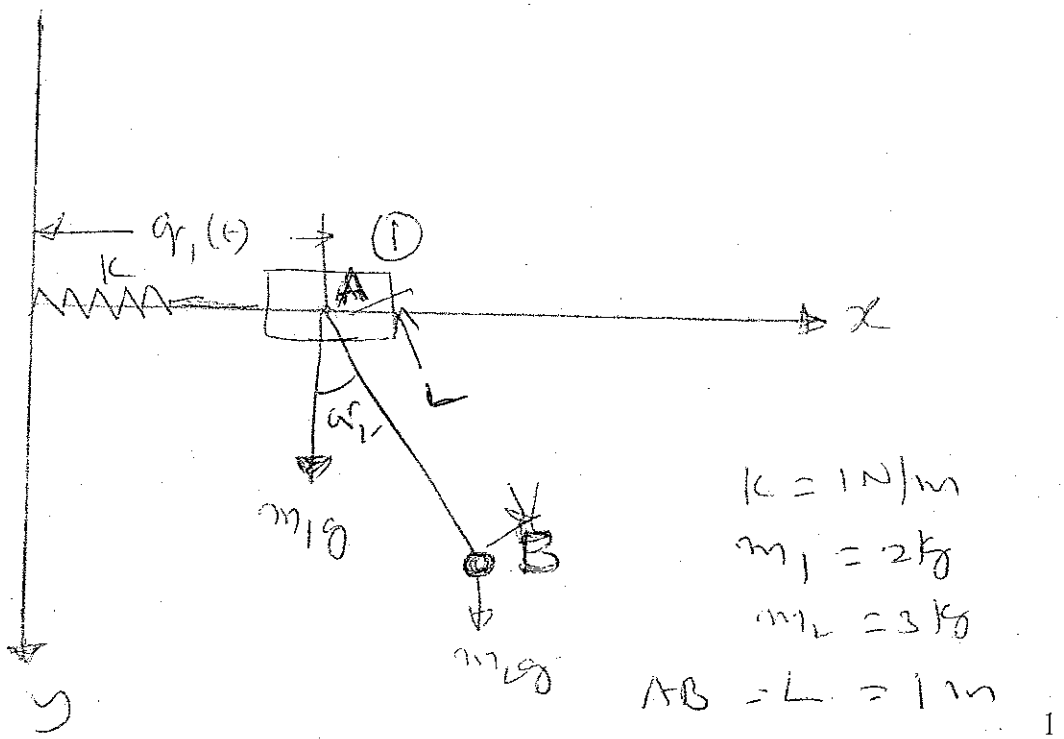
Date: 026-04-20012 **Time: 50 minutes**
Marks: 20 **Weightage: 20%**
Note: 1. Answer all questions.
2. Marks are shown in the brackets against each question.

Question 1

Draw a four bar chainwith the following dimensions:
Fixed link AD= 4m; Driving link AB = 1.5 m; Driven link CD = 2.5 m; coupling link BC = 3M; Angle BAD = 60^0. Link CD revolves at 50 rpm.Driving link is driven by an input torque M_{12}, an external load of P= 100 N is acting at an angle of 200^0 on CD ata distance of 1.5 m from C. Find the input torque using principle of virtual work for static equilibrium. **[10M]**

Question 2

The planar mechanical system shown in the figure below has a slider 1 of mass 2 kg and a pendulum 2 of mass 3 kg concentrated at B. The length of AB is 1 m and the elastic of spring R is 1 N/m. Find out the displacement, velocity and Kinetic energy equations for this system. **[10M]**



Question 3
Write down the unit vectors in radial and tangential directions by showing them on a 2-d plane.Derive the relation between them.

Question 4
Find out the total velocity of a slotted link of 2m length with an angular velocity of 2 rad/s and radial velocity of 1 m/s out wards. Draw the free hand sketch showing the directions.

Question 5
Find out the velocity vector for a 3 m long link, which is rotating at 100 rpm counter clockwise. The link is at angle of 30^0 with the horizontal. Draw the free hand sketch showing clearly the direction.

A

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Q U I Z II

Date: 17-04-2010
Marks: 07 **Duration: 20 Min.**

- **Answer all questions.**
- **Put √ mark in the brackets provided against the suitable answer.**
- **Marks are shown in brackets against each question.**

S E C T I O N A

Question 1 Which of the following can be made dynamically equivalent **[1/2M]**

A piston [ ]

B crank shaft [ ]

C connecting rod [ ]

D cylinder [ ]

Question 2 When 2 bodies are dynamically equivalent, the following parameters of both must be equal. **[1/2M]**

A angular and linear accelerations [ ]

B moments of inertia about centroidal axis [ ]

C forces must be same [ ]

D none of the above [ ]

Question 3 D'Alembert's principle is related to **[1/2M]**

A linear motion only [ ]

B rotary motion only [ ]

C both linear and rotary motion [ ]

D none of the above [ ]

SECTIONB

Question 7

Draw the freehand sketch of vertical recprocating mechanism,showing all the forces. **2M]**

Question 8

Find the acceleration of piston if the crank angle , length of crank shaft and length of connecting rod are 45^0, 150 mm and 600 mm respectively. The crank shaft is rotating at 200 rpm. **[2M]**

Question 4 If the resultant force acting on a rigid body is passing through centroidal Axis, it becomes

A dynamic [ ]

B static [ ]

C neutral [ ]

D none of the above [ ]

Question 5 The condition for connecting rod to be in dynamic equilibrium,, its radius of gyration about its centroidal axis must be
[1/2M]

A arithmetic mean of distances of end masses from C.G [ ]

B harmonic mean of distances of end masses from C.G [ ]

C geometric mean of distance of end masses from C.G [ ]

D none of the above. [ ]

Question 6 Principle of virtual work is related to **[1/2M]**

A static equilibrium [ ]

B dynamic equilibrium [ ]

C both static and dynamo equilibrium [ ]

D none of the above. [ ]

B

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Q U I Z II

Date: 17-04-2010
Marks: 07 **Duration: 20 Min.**

- **Answer all questions.**
- **Put √ mark in the brackets provided against the suitable answer.**
- **Marks are shown in brackets against each question.**
- **Overwriting answers are invalid.**

S E C T I O N A

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SECTIONB

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Question 8

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A

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Q U I Z I

Max. Marks: 08 **Duration: 20 Min.**
Weightage: 8% **Date: 28-02-2012**

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

P A R T I

Question 1
The degree of freedom is defined as

A Number of dependent movements [ ]

B Number of independent movements [ ]

C Number of translations only [ ]

D Number of rotations only [ ]

Question 2
Which of the following represents prismatic pair?

A crankshaft-frame [ ]

B connecting rod-crankshaft [ ]

C piston-cylinder [ ]

D None of the above [ ]

Question 3

How many degrees of freedom are there in E-pair? **[1/2 M]**

A only one [ ]

B two [ ]

C three [ ]

D None of the above [ ]

Question 4

The spherical pair is constrained to have the following degrees of freedom **[1/2 M]**

A three translations [ ]

B three rotations [ ]

C two translations [ ]

D none of the above [ ]

Question 5

The higher pair is constrained to have the following degrees of freedom **[1/2M]**

A one translation only [ ]
B one rotation only [ ]
C one translation and one rotation [ ]
D none of the above [ ]

Question 6

Which one of the following is a double crank mechanism **[1/2M]**

A coupled wheels of a locomotive [ ]
B indicator mechanism [ ]
C shaper mechanism [ ]
D reciprocating engine mechanism [ ]

Question 7

In x-y plane, the following degrees of freedom are possible **[1/2M]**

A translation along z-axis only [ ]
B rotation about z-axis only [ ]
C translation along x, y and rotation about z-axis [ ]
D none of the above [ ]

Question 8

In a 3-d space, the following degrees of freedom are possible **[1/2M]**

A translations along 3 axes only [ ]

B rotations about 3 axes only [ ]

C both translations along and rotations about 3 axes [ ]

D none of the above [ ]

P A R T II

Question 9

Draw the free hand sketches of the following with symbolic representation of the pairs:

(a) four bar chain with all rotating pairs **[1M]**

(b) four bar chain with 3 rotating and one prismatic pair **[1M]**

(c) crankshaft of a reciprocating engine mechanism **[1M]**

(d) connecting rod of a reciprocating engine mechanism **[1M]**