

BITS, PILANI – DUBAI
Dubai International Academic city
ME C392 Advanced Mechanics of Solids & Kinematics
I SEMESTER 2009-2010

C O M P R E H E N S I V E E X A M I N A T I O N

Max. Marks: 40
Weightage: 40%

Duration: 3 hrs.
Date: 24-12-2009

- Answer all questions.
 - Assume suitably any missing data .
 - Marks are shown in brackets against each question.
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Question 1

A point on a machine component is subjected to stresses $\sigma_{xx} = 75$ MPa, $\sigma_{yy} = 65$ MPa, $\sigma_{zz} = 25$ MPa, $\tau_{xy} = 22$ MPa, $\tau_{yz} = 16$ MPa, $\tau_{zx} = 46$ MPa..

Find the normal and shear stresses on an oblique plane whose normal is given by $2i + 3j + 4k$.

[5M]

Question 2

The stress components at a point are given by $\sigma_{xx} = \sigma_{yy} = \sigma_{zz} = 50$ MPa, $\tau_{xy} = 10$ MPa, $\tau_{yz} = 20$ MPa, $\tau_{zx} = 15$ MPa. Calculate the strain invariants.

The modulus of elasticity and Poisson's ratio are 200 GPa and 0.3 respectively.

[5M]

Question 3

Draw the sketches(not free hand) of simple gear train with 4 idle wheels and compound Gear train with 6 gears such that odd numbered wheels are drivers and even numbered wheels as followers. The directions of all the gears should be shown.

[4M]

Question 4

The crank of a slider crank chain mechanism is 150 mm and the connecting rod is 600 mm long. The crank makes 300 rpm in the clock-wise direction. When it has turned 45° from the top dead centre position, determine the velocity and acceleration of the mid point of connecting rod. Draw velocity and acceleration diagrams to scale. **[10M]**

Question 5

The arm of an epicyclic gear train rotates at 150 rpm in the clock-wise direction. The Arm carries two wheels X and Y having 40 and 50 teeth respectively. The wheel X is Fixed and the arm Z rotates about the centre of wheel X. Find the speed of wheel Y. What will be the speed of wheel Y instead of being fixed, makes 300 rpm clock-wise? Draw the free hand sketch of the gear train. [6M]

Question 6

Draw the profile of a cam, operating a knife-edged follower when the axis of follower passes through the axis of cam shaft from the following data:

Stroke of the follower	=	60 mm.
Least radius of cam	=	50 mm
Angle of outward stroke	=	50°
Angle of next dwell	=	45°
Angle of return	=	80°

Remaining period is dwell. The displacement of the follower is to take place with Uniform motion during both the outward and return strokes. Draw the follower displacement diagram and then construct the cam profile. [10M]

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I SEMESTER 2009-2010

T E S T II (OPEN BOOK) ~~Marks~~

Max. Marks: 20

Duration: 50 Min.

Date: 16-12-2009

- Answer all questions.
 - Assume any missing data.
 - Marks are shown in brackets against each question.
 - Text book and hand-written class notes are only allowed.
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Question 1

Draw the four bar chain with the following dimensions:

AB = 75 mm; BC = 175 mm; CD = 150 mm; AD = 100 mm and AD, which is fixed perpendicular to the link AB. If the input link AB rotates at 130 rpm clock-wise, find the angular velocities of links BC and DC. Find also the velocity of point E on link BC, which is at a distance of 56 mm from C. **(8M)**

Question 2

Draw the horizontal engine reciprocating mechanism with the following dimensions:

The crank OC = 100 mm ; connecting rod CP = 300 mm; the crank angle is 120° with the line of stroke.

If the crank has a velocity of 70 rad/s and an angular acceleration of 1200 rad/s^2 Find the velocity of piston and total acceleration of crank. **(8M)**

Question 3

Draw the free hand sketch of the compound gear train with the following details:

The power is transmitted from the motor shaft, connected to gear 1 to the out put shaft, connected to gear 6. Gears 1, 3 and 5 are drivers, where as gears 2,4 and 6 are followers. Gears 2-3 and gears 4-5 are compounded.. Find the train value if the number of teeth on gears 1,2,3,4,5, and 6 are 32,76,40,125, 28 and 70 respectively. The speed of motor shaft is 1000 rpm clock-wise. Show the directions of rotation of all the gears. **(4M)**

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I SEMESTER 2009-2010

T E S T I (Closed Book)

Marks: 25

Duration: 50 Minutes

Date: 01-11-2009

- Answer all questions.
- Marks are shown in brackets against each question.
- Assume any missing data suitably.

Question 1

The stress components at a point are: $\sigma_{xx} = 100 \text{ MPa}$, $\sigma_{yy} = -100 \text{ MPa}$, $\sigma_{zz} = 0$, $\sigma_{xy} = 50 \text{ MPa}$, $\sigma_{xz} = 0$, $\sigma_{yz} = 0$. Find the normal and shear stresses on the plane defined by unit normal \mathbf{N} : $(l = \frac{1}{\sqrt{2}}, m = \frac{1}{\sqrt{2}}, n = 0)$. [5M]

Question 2

Consider the displacements given by the following relations: $u = C_1 x^2$, $v = C_2 y^2$, $w = C_3 z^2$, where (u, v, w) denote the (x, y, z) components of the displacement of P ($x=1, y=1, z=2$) to $P^*(x^*=1.004, y^*=1.002, z^*=1.996)$. Find the magnitudes of C_1 , C_2 , and C_3 . Find the normal and tangential strain components at the point P . [6M]

Question 3

The state of stress at a point in a machine part relative to the (x, y, z) axes, is given by $\sigma_{xx} = -20 \text{ MPa}$, $\sigma_{yy} = 50 \text{ MPa}$, $\sigma_{xy} = 10 \text{ MPa}$, $\sigma_{xz} = \sigma_{yz} = \sigma_{zz} = 0$. Determine

- (a) stress invariants and principal stresses and
- (b) orientation of the principal axes in terms of direction cosines. [6M]

Question 4

Consider a machine component subjected to the following state of stress relative to the (x, y, z) axes, $\sigma_{xx} = 20 \text{ MPa}$, $\sigma_{yy} = 10 \text{ MPa}$, $\sigma_{zz} = 15 \text{ MPa}$, $\sigma_{xy} = 10 \text{ MPa}$, $\sigma_{xz} = 10 \text{ MPa}$, $\sigma_{yz} = 20 \text{ MPa}$. Find the principal stresses and maximum shear stress from the Mohr's circles. [8M]

NAME: _____
ID.NO: _____

**BITS, PILANI –DUBAI,
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ME C392 Advanced Mechanics of Solids & Kinematics
I SEMESTER 2009-2010**

Q U I Z II

**Max. Marks: 14
Weightage: 7%**

**Duration: 20 Min.
Date: 09-12-2009**

- Answer all questions.
 - Marks are shown in the brackets against each question.
 - Write the answers below each question.
-

Question 1

What is instantancous centre?

[1M]

Question 2

What are the types of instant centre?

[1M]

Question 3

State Kennedy's theorem.

[1M]

Question 4

Draw the sketch, showing simple gear train with 3 idle wheels

[1M]

Question 5

Where do you locate instantaneous centre for a piston in a horizontal reciprocating engine mechanism.

[1M]

Question 6

What is the magnitude of centripetal acceleration for the piston?

[1M]

Question 7

What is the difference between train value and velocity ratio in a gear train?

[1M]

Question 8

How many instantaneous centres are there in a 6-bar mechanism?

[1M]

Question 9

If the absolute velocities of two points on a link of 2 m length are 2 m/s along positive x-direction and 3 m/s at angle of 30° with respect to positive sense of x-axis, find the angular velocity of the link. Draw the free hand sketch.

[3M]

Question 10

If a 4 m long link is rotating at a uniform speed of 100 rpm in a clock-wise direction, find the total acceleration of the link. Show also the directions of both the velocity and acceleration if the link is fixed to a frame at an angle of 45° with respect to positive sense of x-axis. Draw the free hand sketch.

[3M]

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ID No: _____

**BITS, PILANI – DUBAI,
DUBAI INTERNATIONAL ACADEMIC CITY
First Semester 2009-2010
Q U I Z I**

ME C392 Advanced Mechanics of Solids & Kinematics

**Max Marks: 16
Weightage: 8%**

**Date: 14-10-09
Time: 20 minutes**

- Note:**
1. Answer all questions.
 2. Marks are shown in the brackets against each question.
 3. Solutions/answers should be given in the space provided below the question.

Question 1

The stress components at a point are given by $\sigma_{xx} = 70$ MPa, $\sigma_{yy} = 10$ MPa, $\sigma_{zz} = -20$ MPa, $\tau_{xy} = -40$ MPa, $\tau_{yz} = \tau_{zx} = 0$. Determine mean and deviatoric stress tensors. **[3M]**

Question 2

State Castigliano's theorem on deflections.

[1M]

Question 3

The stress components at a point are given by $\sigma_{xx} = 120 \text{ MPa}$, $\sigma_{yy} = -50 \text{ MPa}$, $\sigma_{zz} = 50 \text{ MPa}$, $\tau_{xy} = -50 \text{ MPa}$, $\tau_{yz} = 30 \text{ MPa}$, $\tau_{zx} = -75 \text{ MPa}$. Calculate octahedral normal and shear stresses.

Question 4

Draw the free hand sketch showing all the stress components in a 3 d stress State. [1M]

Question 5

A point on a machine component is subjected to stresses $\sigma_{yy} = 75 \text{ MPa}$, $\sigma_{yz} = 65 \text{ MPa}$, $\sigma_{zz} = 25 \text{ MPa}$. Find the principal stresses and maximum shear stress. [3M]

Question 6

Write down the equation for finding principal stresses in 3-d stress state in terms of stress invariants. [1M]

Question 7

The stress components at a point are given by $\sigma_{xx} = 20$ MPa, $\sigma_{yy} = 10$ MPa, $\sigma_{zz} = 15$ MPa, $\tau_{xy} = 5$ MPa, $\tau_{yz} = 10$ MPa, $\tau_{zx} = 20$ MPa. Determine the stress vector on a plane normal to the vector $\mathbf{i} + 2\mathbf{j} + \mathbf{k}$. [3M]

Question 8

What do you mean by octahedral plane?

[1M]