

**BITS, PILANI – DUBAI**  
**Dubai International Academic city**  
**ME C392 Advanced Mechanics of Solids & Kinematics**  
**I SEMESTER 2007-2008**

**T E S T I**

**Max. Marks: 25**

**Duration: 50 Min.**

**Date: 12-10-2008**

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

The stress components at a point are given by  $\sigma_{xx} = 120$  MPa,  $\sigma_{yy} = -55$  MPa,  $\sigma_{zz} = 50$  MPa,  $\tau_{xy} = -55$  MPa,  $\tau_{yz} = 33$  MPa,  $\tau_{zx} = -75$  MPa. Calculate

- (a) Stress invariants.
- (b) Normal and shear stresses on an oblique plane with normal vector  $N : i + 2j + k$ .
- (c) Draw the free hand sketch, showing all the stress components on 3-d state of stress. [10M]

**Question 2**

The strain components at a point are given by  $\epsilon_{xx} = 201 \mu$ ,  $\epsilon_{yy} = -192 \mu$ ,  $\epsilon_{zz} = -241 \mu$ ,  $\epsilon_{xy} = 267 \mu$ ,  $\epsilon_{yz} = -150 \mu$ ,  $\epsilon_{zx} = -170 \mu$ , find mean and Deviatoric stress tensors if modulus of rigidity and Poisson's ratio are 26 GPa and 0.30 respectively. [9M]

**Question 3**

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 stresses on X, Y and Z surfaces if the direction cosines of X, Y and Z axes with respect to the given axes x, y and z are ( 1,2, 1 ), (2, 1, 3) And (1, 3, 2) respectively. [6M]

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**I SEMESTER 2008-2009**

**T E S T II (Open Book)**

**Marks: 20**  
**Weightage: 20%**

**Duration: 50 Min.**  
**Date: 23-11-2008**

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- Prescribed text book and hand-written class notes are only allowed.
  - Answer all questions.
  - Marks are shown in brackets against each question.
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**Question 1**

Draw a simple gear train of 4 gears, in which the gear 1 and gear 4 are fixed to the input and output shafts respectively. The number of teeth on gears 1, 2, 3 and 4 are 30, 40, 50 and 60 respectively. If the input shaft rotates at 1200 rpm in clock-wise direction, find the magnitude and direction of output shaft.

**[3 M]**

**Question 2**

In a compound gear train of 4 gears (gear 1 and gear 4 are attached to input and output shafts, gear 2 and gear 3 are compounded). The input shaft is rotating at 1000 rpm in counter-clockwise direction. The number of teeth on gears 1, 2, 3 and 4 are 30, 70, 40 and 110 respectively. Draw the gear train and find the magnitude and direction of speed of output shaft.

**[4 M]**

**Question 3**

Draw an epicyclic gear train in which the arm A is rotating at 80 rpm in counter clock-wise direction. The arm A carries two gears B and C having 32 and 40 teeth respectively. Find

(a) the speed of gear C if the gear B is fixed and the arm A rotates about the centre of gear B and

(b) the speed of C if the gear B instead of being fixed, makes 160 rpm clock-wise.

**[5 M]**

**Question 3**

The length of crank and connecting rod of a horizontal reciprocating engine are 100 mm and 500 mm respectively. The crank is rotating at 400 rpm. Find

(a) velocity and acceleration of piston and

(b) angular velocity and angular acceleration of connecting rod when the crank has turned  $30^\circ$  from inner dead centre by drawing the configuration, velocity and acceleration diagrams to scale using relative velocity and acceleration methods.

**[8 M]**

NAME: \_\_\_\_\_  
ID.NO: \_\_\_\_\_

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**QUIZ III**

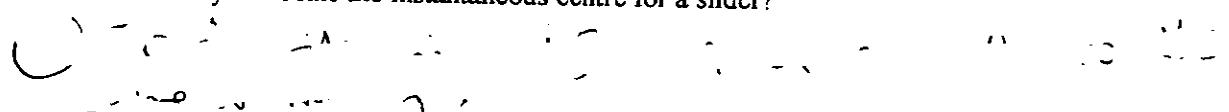
Max. Marks: 10  
Weightage: 5%

Duration: 15 Min.

- Answer all questions.
- Each question carries 1 mark.
- Write the answers below each question.

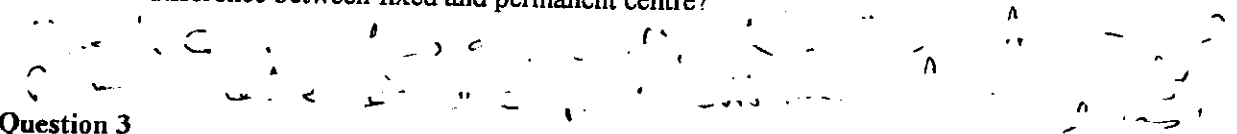
**Question 1**

Where do you locate the instantaneous centre for a slider?



**Question 2**

What is the difference between fixed and permanent centre?



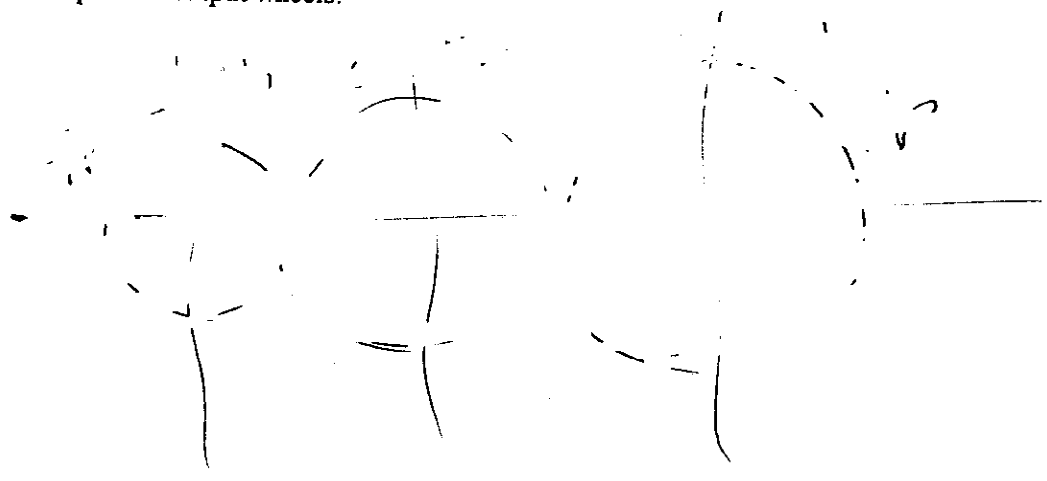
**Question 3**

State Kennedy's theorem. [



**Question 4**

Draw the sketch, showing simple gear train, having the same direction of rotation for both the input and output wheels.



**Question 5**

What is the value of radial acceleration of piston?

*Handwritten scribbles*

**Question 6**

What is the difference between circular pitch and diametral pitch/?

*Handwritten notes and diagrams for Question 6*

**Question 7**

What is the magnitude of centripetal acceleration for the piston?

*Handwritten scribbles*

**Question 8**

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

*Handwritten notes and diagrams for Question 8*

**Question 9**

Which gear train is used for a watch mechanism?

*Handwritten notes for Question 9*

**Question 10**

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

*Handwritten notes for Question 10*

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**COMPREHENSIVE EXAMINATION**

Max. Marks: 40  
Weightage: 40%

Duration: 3 hrs.  
Date: 06-01-2009

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

**Question 1**

The stress components at a point are given by  $\sigma_{xx} = 70 \text{ MPa}$ ,  $\sigma_{yy} = 10 \text{ MPa}$ ,  $\sigma_{zz} = -20 \text{ MPa}$ ,  $\tau_{xy} = -40 \text{ MPa}$ ,  $\tau_{yz} = \tau_{zx} = 0$ . Determine

- (a) the principal stresses and
- (b) deviatoric stress tensor.

[5M]

**Question 2**

The strain components at a point are given by  $\epsilon_{xx} = 100 \mu$ ,  $\epsilon_{yy} = 50 \mu$ ,  $\epsilon_{zz} = 40 \mu$ ,  $\epsilon_{xy} = 40 \mu$ ,  $\epsilon_{yz} = 20 \mu$ ,  $\epsilon_{zx} = 20 \mu$ , find the normal and shearing strains on a plane whose normal vector is  $i + 2j$ .

[5M]

**Question 3**

Define shear centre and locate the shear centre for the channel section, shown in the Fig. Q3.

[5M]

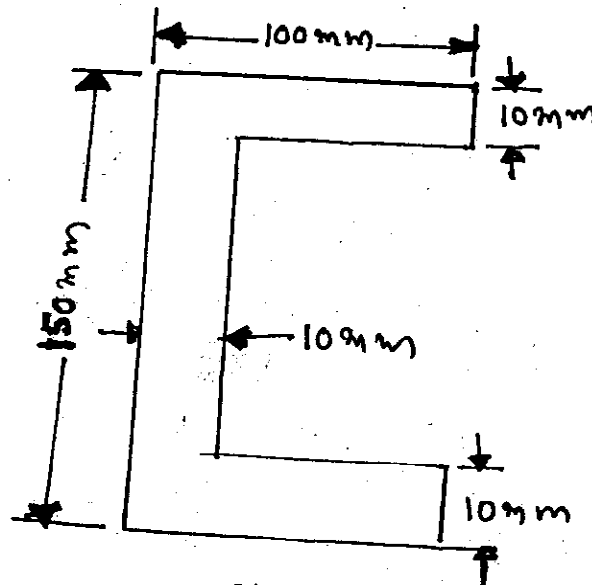


Fig. Q3

**Question 4**

A four bar chain is represented by a quadrilateral ABCD in which AD is fixed and 2 in long. The crank AB 62.5 mm long rotates in a clock-wise direction at 95.5 rpm. and drives the link CD 112.5 mm long by means of the connecting link BC 175 mm long. Draw the configuration, velocity and acceleration diagrams to scale, when the angle BAD =  $60^\circ$ . Determine the angular velocities and angular accelerations of links BC and CD. [10M]

**Question 5**

In a reverted epicyclic train, the arm F carries two wheels A and D and a compound wheel B-C. The wheel A meshes with wheel B and the wheel D meshes with wheel C. The number of teeth on wheels A, D and C are 80, 48 and 72 respectively. Find the speed and direction of wheel D when wheel A is fixed and arm F makes 200 rpm clock-wise. Draw the free hand sketch of the gear train. [5M]

**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	=	50 mm.
Least radius of cam	=	60 mm
Angle of outward stroke	=	$60^\circ$
Angle of next dwell	=	$45^\circ$
Angle of return	=	$90^\circ$

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