

Faculty of Engineering

End Semester Examination May 2025

AU3CO33 / AU3CO59 Mechanics of Machines / Theory of Machines

Programme	:	B.Tech.	Branch/Specialisation	:	AU
Duration	:	3 hours	Maximum Marks	:	60

Note: All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary.
Notations and symbols have their usual meaning.

Section 1 (Answer all question(s))				Marks CO BL
Q1. The relation between the number of pairs (p) forming a kinematic chain and the number of links (l) is-				1 1 1
<input type="radio"/> 1 = 2p - 2			<input type="radio"/> 1 = 2p - 3	
<input checked="" type="radio"/> 1 = 2p - 4			<input type="radio"/> 1 = 2p - 5	
Q2. The Grubler's criterion for determining the degrees of freedom (n) of a mechanism having plane motion is-				1 1 1
<input type="radio"/> n = (l - 1) - j			<input type="radio"/> n = 2(l - 1) - 2j	
<input checked="" type="radio"/> n = 3(l - 1) - 2j			<input type="radio"/> n = 4(l - where l = Number of links, and j = 1) - 3j Number of binary joints.	
Q3. The total number of instantaneous centres for a mechanism consisting of n links are-				1 1 1
<input type="radio"/> n/2			<input type="radio"/> n	
<input type="radio"/> n - 1/2			<input checked="" type="radio"/> n(n - 1)/2	
Q4. According to Aronhold Kennedy's theorem, if three bodies move relatively to each other, their instantaneous centres will lie on a-				1 1 1
<input checked="" type="radio"/> Straight line			<input type="radio"/> Parabolic curve	
<input type="radio"/> Ellipse			<input type="radio"/> None of these	
Q5. The angle between the direction of the follower motion and a normal to the pitch curve is called-				1 2 1
<input type="radio"/> Pitch angle			<input type="radio"/> Prime angle	
<input type="radio"/> Base angle			<input checked="" type="radio"/> Pressure angle	
Q6. The cam follower generally used in automobile engines is-				1 2 1
<input type="radio"/> Knife edge follower			<input type="radio"/> Flat faced follower	
<input checked="" type="radio"/> Spherical faced follower			<input type="radio"/> Roller follower	
Q7. An imaginary circle which by pure rolling action, gives the same motion as the actual gear, is called-				1 2 1
<input type="radio"/> Addendum circle			<input type="radio"/> Dedendum circle	
<input checked="" type="radio"/> Pitch circle			<input type="radio"/> Clearance circle	
Q8. In a simple gear train, if the number of idle gears is odd, then the motion of driven gear will-				1 3 1
<input checked="" type="radio"/> Be same as that of driving gear			<input type="radio"/> Be opposite as that of driving gear	
<input type="radio"/> Depend upon the number of teeth on the driving gear			<input type="radio"/> None of these	
Q9. The engine of an aeroplane rotates in clockwise direction when seen from the tail end and the aeroplane takes a turn to the left. The effect of the gyroscopic couple on the aeroplane will be-				1 3 1
<input checked="" type="radio"/> To raise the nose and dip the tail			<input type="radio"/> To dip the nose and raise the tail	
<input type="radio"/> To raise the nose and tail			<input type="radio"/> To dip the nose and tail	

Q10. In an automobile, if the vehicle makes a left turn, the gyroscopic torque-

1 3 1

- Increases downward forces on the outer wheels
- Decreases downward forces on the outer wheels
- Does not affect the forces on the outer wheels
- None of the above

Section 2 (Answer all question(s))

Marks CO BL

Q11. Explain the terms with neat sketches :

4 1 1

- (i) Kinematic Pair
- (ii) Kinematic chain
- (iii) Mechanism
- (iv) Inversion

Rubric	Marks
Explain with diagram - One marks each	4

Q12. (a) Explain any two inversions of a single slider crank chain with neat sketches.

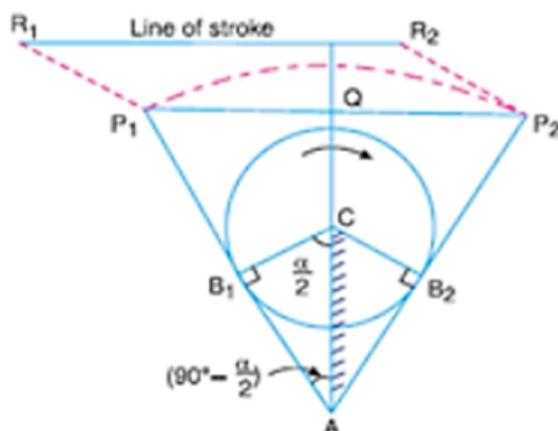
6 2 2

Rubric	Marks
Two inversions with sketches - 3 marks each	6

(OR)

- (b)** In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres AC is 240 mm and the length of the driving crank BC is 120 mm. Find the inclination of the slotted bar with the vertical in the extreme position and the time ratio of cutting stroke to the return stroke.

If the length of the slotted bar is 450 mm, find the length of the stroke if the line of stroke passes through the extreme positions of the free end of the lever.



Rubric	Marks
Inclination of the slotted bar with the vertical = $\sin^{-1} 0.5 = 30^\circ$ Ans.	2
Time ratio of cutting stroke to the return stroke = 2 Ans.	2
Length of the stroke = 450 mm Ans	2

Section 3 (Answer all question(s))

Marks CO BL

Q13. Discuss the three types of instantaneous centres for a mechanism with an example.

4 1 1

Rubric	Marks
Each one marks and diagram one marks	4

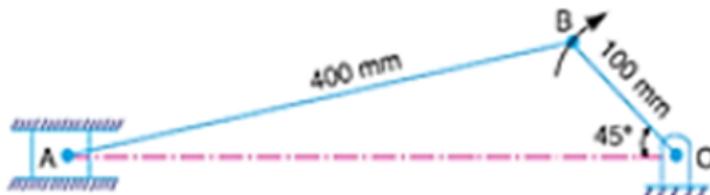
Q14. (a) State and prove the ‘Aronhold Kennedy’s Theorem’ of three instantaneous centres.

6 2 2

Rubric	Marks
‘Aronhold Kennedy’s Theorem’	2
State and prove the ‘Aronhold Kennedy’s Theorem’ of three instantaneous centres with diagram	4

(OR)

- (b)** The lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, find: 1. Velocity of the slider A, and 2. Angular velocity of the connecting rod AB. using relative velocity method.



Rubric	Marks
1. Velocity of the slider A = 0.82 m/s	3
2. Angular velocity of the connecting rod AB = 1.78 rad/s	3

Section 4 (Answer all question(s))

Q15. Define the following terms as applied to cam with a neat sketch :-

- (i) Base circle, (ii) Pitch circle, (iii) Pressure angle, and (iv) Stroke of the follower.

Marks CO BL

4 1 1

- Q16. (a)** Draw the displacement, velocity and acceleration diagrams for a follower when it moves with simple harmonic motion. Derive the expression for velocity and acceleration during outstroke and return stroke of the follower.

6 3 3

Rubric	Marks
Each term of one marks	4
Draw the displacement, velocity and acceleration diagrams	3
Expression for velocity and acceleration	3

(OR)

- (b)** A cam is to be designed for a knife edge follower with the following data :
 (i) Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion.
 (ii) Dwell for the next 30° .
 (iii) During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion.
 (iv) Dwell during the remaining 180° .

Draw the profile of the cam when the line of stroke of the follower passes through the axis of the cam shaft. The radius of the base circle of the cam is 40 mm. Determine the maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 240 r.p.m.

Rubric	Marks
Cam Profile	4
(b) the maximum velocity and acceleration of the follower	2

Section 5 (Answer all question(s))

Marks CO BL

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Q17. Explain the terms : (i) Module, (ii) Pressure angle, (iii) Addendum and (iv) Dedendum

4 1 1

Rubric	Marks
Each one marks	4

Q18. (a) State and prove the law of gearing. Show that involute profile satisfies the conditions for correct gearing.

6 3 2

Rubric	Marks
State and prove the law of gearing [4 Marks]	6
Involute profile satisfies law of gearing [2 Marks]	

(OR)

(b) Explain briefly the differences between simple, compound, and epicyclic gear trains. What are the special advantages of epicyclic gear trains ?

Rubric	Marks
Two Marks for each gear train with simple sketch !	6

Section 6 (Answer any 2 question(s))

Marks CO BL

Q19. What do you understand by gyroscopic couple? Derive a formula for its magnitude.

5 2 2

Rubric	Marks
gyroscopic couple	2
Derive a formula for its magnitude.	3

Q20. Discuss the effect of Gyroscopic Couple on a four wheeler while taking a turn.

5 2 2

Q21. Find the angle of inclination with respect to the vertical of a two wheeler negotiating a turn. Given : combined mass of the vehicle with its rider 250 kg ; moment of inertia of the engine flywheel 0.3 kg-m^2 ; moment of inertia of each road wheel 1 kg-m^2 ; speed of engine flywheel 5 times that of road wheels and in the same direction ; height of centre of gravity of rider with vehicle 0.6 m ; two wheeler speed 90 km/h ; wheel radius 300 mm ; radius of turn 50 m.

5 3 3

Rubric	Marks
gyroscopic couple $C_1 = 146 \cos \theta \text{ N-m}$	1
centrifugal couple $C_2 = 1875 \cos \theta \text{ N-m}$	1
\therefore Total overturning couple $= C_1 + C_2 = 146 \cos \theta + 1875 \cos \theta = 2021 \cos \theta \text{ N-m}$	1
balancing couple $= m.g.h \sin \theta = 250 \times 9.81 \times 0.6 \sin \theta = 1471.5 \sin \theta \text{ N-m}$	1
$\theta = 53.94^\circ$ Ans	1
