B **518B3** **Total pages: 3**

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SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FOURTH SEMESTER B.TECH. DEGREE EXAMINATION(R,S), MAY 2024

Robotics and Automation

(2020 SCHEME)

Course Code : 20RBT202

Course Name : Kinematics and Dynamics of Mechanisms

Max. Marks : 100 **Duration:3 Hours**

Scientific calculator and statistical table is allowed in the examination hall.

PART A

(Answer all questions. Each question carries 3 marks)

1. Explain the terms (i) Analysis (ii) Synthesis (iii) Kinematics
2. Explain limit/toggle position and its significance.
3. State and prove Aronhold-Kennedy's theorem of three centres.
4. Describe the procedure to construct configuration diagram of a simple four bar mechanism.
5. Define (i) static force analysis (ii) static equilibrium.
6. Define (i) Dynamic force analysis (ii) Inertia torque.
7. What do you mean by Lagrangian formulation for manipulator dynamics?
8. Explain various types of rigid body motions.
9. Distinguish between transverse and torsional vibrations.
10. Write the expression to find amplitude of steady state response in forced-damped vibrations.

PART B

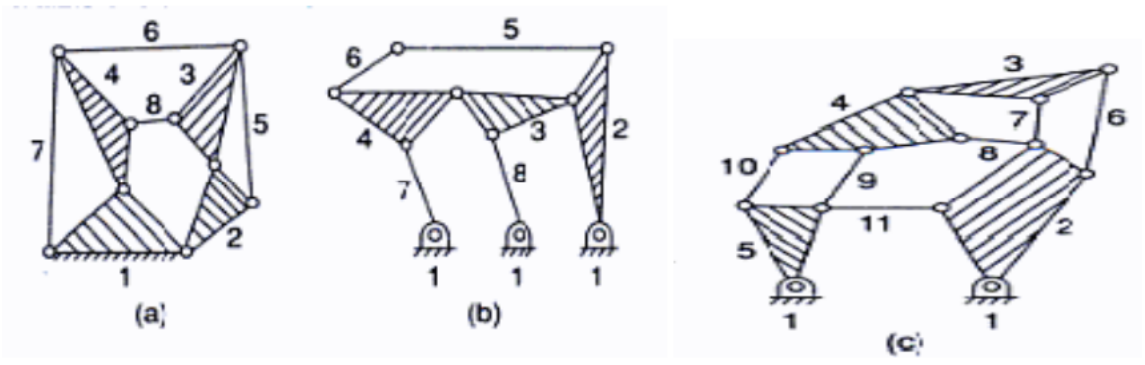
(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. What are inversions? Briefly explain the types of inversions in slider crank mechanism and application for each. 14

OR

12. 14



For the kinematic linkages shown in the figure, calculate the following:
(a) The number of binary (Nb) and ternary links (Nt)

(b) The number of other (quaternary, etc.) links (No)
(c) The number of total links (N) and loops (L)
(d) The number of joints or pairs (P)
(e) The number of degrees of freedom (F)

MODULE II

13. Explain total acceleration and Corioli's component of acceleration. Derive an expression to find magnitude of Corioli's component of acceleration with a neat figure. Show the possible directions. 14

OR

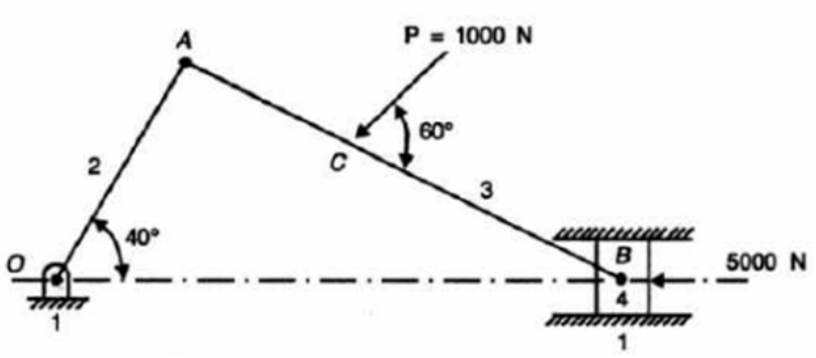
14. Explain the position analysis of a four bar mechanism using vector loop closure method. 14

MODULE III

15. (a) Explain the conditions for a system to be dynamically equivalent ? 6
(b) Derive an expression to find the inertia of connecting rod. 8

OR

16. Determine the torque required to be applied at the crank shaft of a slider crank mechanism to bring it in equilibrium. The slider is subjected to a horizontal force of 5000 N and a force of magnitude 1000 N is applied on the connecting rod. The dimensions of various links are OA = 250 mm, AB = 750 mm and AC = 250 mm. 14



MODULE IV

17. Derive an expression for inverse dynamics analysis of a single link in pure rotation. 14

OR

18. Derive the expression for inverse dynamics analysis of a slider crank mechanism with a aid of a suitable diagram. 14

MODULE V

19. A mass of 4.5 kg, hangs from a spring and makes damped vibration. The time of 50 complete oscillations is found to be 18 seconds and the ratio of first down ward displacement to the sixth is found to be 2.5. 14
Find:
(i) Natural frequency of the system.
(ii) Stiffness of the spring in KN/m.
(iii) Damping coefficient in N-s/m.
(iv) Critical damping coefficient.

OR

20. The following data relate to a machine supported on four springs: 14
Mass of the machine = 120kg
Stroke = 90mm
Mass of reciprocating parts = 2.5kg
Speed = 750rpm
The springs are placed symmetrically with respect to the centre of mass of the machine. Neglecting damping, find the combined stiffness of the springs so that the force transmitted to the foundation is 1/22 of the impressed force.

If under actual working conditions, the damping reduces the amplitude of the successive vibrations by 25%, determine the forces transmitted to the foundation at 750 rpm and at resonance. Also find the amplitude of the vibrations at resonance.

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