BT MRE-IV(R/S)-06-24-3239 Reg. No. | | | | | | | | |

A

# *B.Tech. Degree IV Semester Regular/Supplementary Examination in Marine Engineering June 2024*

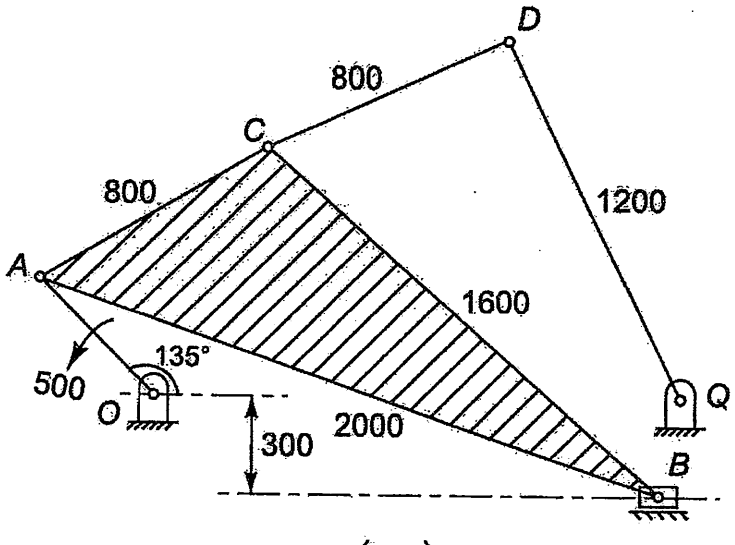
**19-208-0401 MECHANICS OF MACHINERY**
*(2019 Scheme)*

Time: 3 Hours Maximum Marks: 60

Course Outcome
On successful completion of the course, the students will be able to:

CO1: Understand the different kinematic chain and their inversions and analyse their kinematics.
CO2: Analyze the different path generation mechanism and design cams and followers for specified motion profiles.
CO3: Understand different types of governors and their characteristics.
CO4: Evaluate gear tooth geometry and select appropriate gears for the required applications.
CO5: Design belts and ropes, clutches, brakes and dynamometers for industrial applications.
Bloom's Taxonomy Levels (BL): L1 – Remember, L2 – Understand, L3 – Apply, L4 –Analyze, L5 – Evaluate, L6 – Create
PI – Programme Indicators

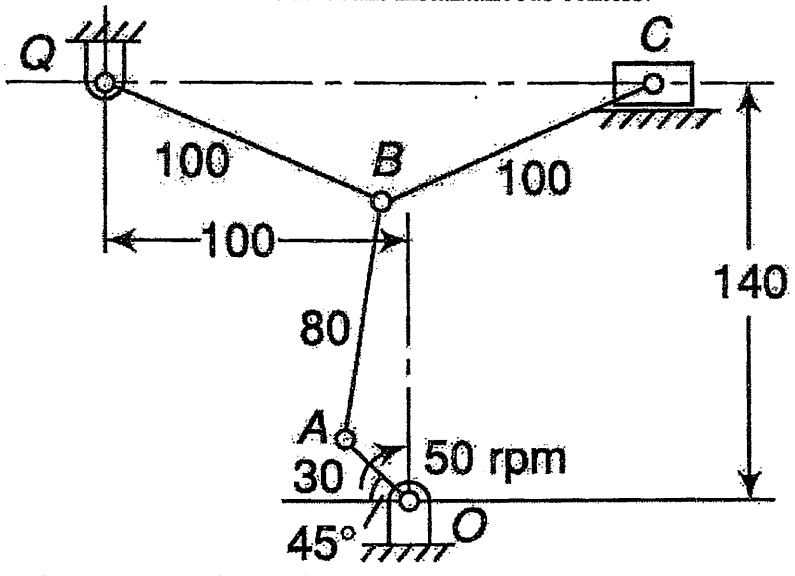
(Answer *ALL* questions) (5 × 15 = 75)

| | | Marks | BL | CO | PI |
|---|---|---|---|---|---|
| I. |  (mm) | | | | |
| | In the mechanism shown in figure the link OA has an angular velocity of 10 rad/s. | | | | |
| (a) | Draw the velocity polygon of the mechanism. | 10 | L4 | 1 | 1.3.1 |
| (b) | Determine the velocities of points B, C and D. | 3 | L2 | 1 | 1.3.1 |
| (c) | Determine the angular velocities of ABC and QD. | 2 | L2 | 1 | 1.3.1 |

**OR**

**(P.T.O.)**

| | | | Marks | BL | CO | PI |
|---|---|---|---|---|---|---|
| II. | (a) | Figure shows a toggle mechanism along with the dimensions of the links in mm. Locate all the relevant instantaneous centers. | 12 | L4 | 1 | 1.3.1 |




| | | | | | | |
|---|---|---|---|---|---|---|
| | (b) | Find the velocities of the points B and C. | 1 | L2 | 1 | 1.3.1 |
| | (c) | Find the angular velocities of links AB, BQ and BC. | 2 | L1 | 1 | 1.3.1 |
| III. | (a) | Explain various terminologies associated with a cam-follower mechanism. | 5 | L1 | 2 | 1.3.1 |
| | (b) | Explain the procedure to construct a displacement diagram for a cycloidal motion of the follower. Derive the expressions for displacement, velocity and acceleration of a follower in this case. Show the typical curves of displacement, velocity, acceleration and jerk for this type of motion and justify why it is most ideal programme for high-speed follower motion. | 10 | L2 | 2 | 1.3.1 |

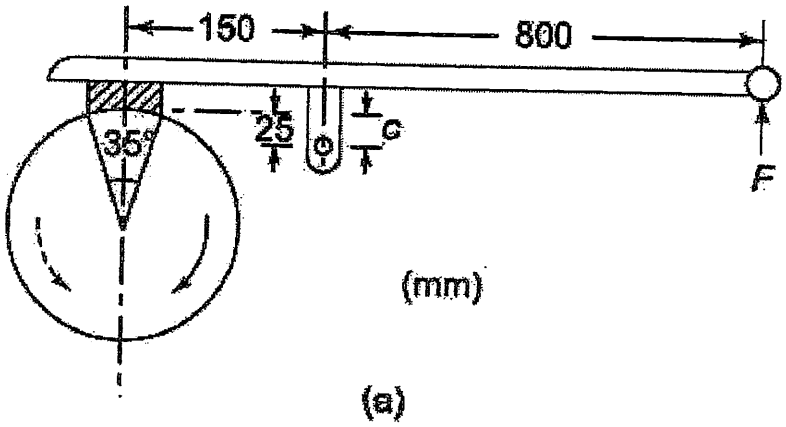
**OR**

| | | | | | | |
|---|---|---|---|---|---|---|
| IV. | (a) | Draw the displacement diagram of the follower in the following case and explain the procedure used. The following data relate to a cam profile in which the follower moves with cycloidal motion during ascent and uniform acceleration and deceleration during descent.<br>Minimum radius of cam = 25 mm<br>Roller diameter = 12 mm<br>Lift = 28 mm<br>Offset of follower axis = 12 mm towards right<br>Angle of ascent = 60°<br>Angle of descent = 90°<br>Angle of dwell between ascent and descent = 45°<br>Speed of the cam = 200 rpm<br>The uniform deceleration is 2/3$^{rd}$ of the uniform acceleration during the descent of the follower. | 5 | L4 | 2 | 1.3.1 |
| | (b) | Draw the cam profile. | 8 | L3 | 2 | 1.3.1 |
| | (c) | Calculate the maximum values of velocity and acceleration during ascent and descent of the follower motion. | 2 | L2 | 2 | 1.3.1 |

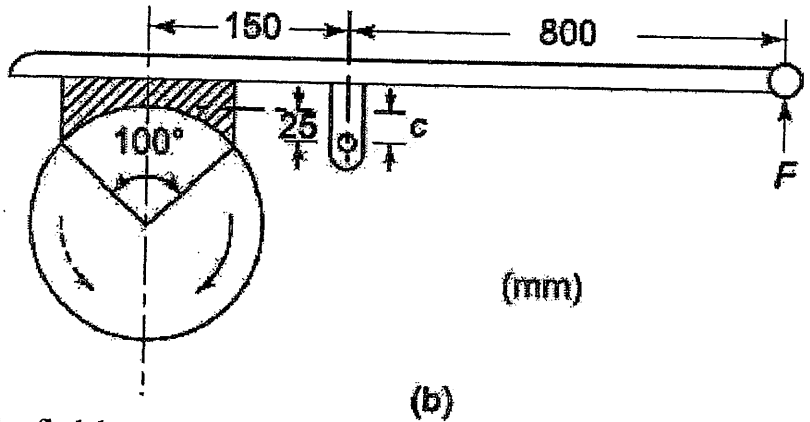
**(Continued)**

| | | | Marks | BL | CO | PI |
|---|---|---|---|---|---|---|
| V. | (a) | The mass of each ball of a Proell governor is 7.5 kg and the load on the sleeve is 80 kg. Each arm is 300 mm long. The upper arms are pivoted on the axis of rotation whereas the lower arms are pivoted to links of 40 mm from the axis of rotation. The extensions of the lower arms to which the balls are attached are 100 mm long and parallel to the governor axis at the minimum radius. Determine the equilibrium speeds corresponding to extreme radii of 180 mm. | 5 | L3 | 3 | 1.3.1 |
| | (b) | Determine the equilibrium speeds corresponding to extreme radii of 240 mm considering the obliquity of the arms. | 10 | L4 | 3 | 1.3.1 |
| | | **OR** | | | | |
| VI. | (a) | What is meant by effort and power of a governor? Find the expressions for the same in a Porter governor. | 6 | L2 | 3 | 1.3.1 |
| | (b) | Each arm of a Porter governor is 250 mm long and is pivoted on the axis of rotation. The mass of each ball is 5 kg and the sleeve is 25 kg. The sleeve begins to rise when the radius of rotation of the balls is 150 mm and reaches the top when it is 200 mm. Determine the range of speed, lift of the sleeve, governor effort and power. | 4 | L3 | 3 | 1.3.1 |
| | (c) | In what way are the above values changed if friction at the sleeve is equivalent to 10 N. | 5 | L3 | 3 | 1.3.1 |
| VII. | (a) | State and derive the law of gearing. | 6 | L2 | 4 | 1.3.1 |
| | (b) | Two involute gears in a mesh have a pressure angle of 20° and a module of 8 mm. The larger gear has 57 while the pinion has 23 teeth. The addenda on pinion and gear wheels are equal to one module. Determine contact ratio. | 3 | L3 | 4 | 1.3.1 |
| | (c) | Angle of action of the pinion and the gear wheel. | 3 | L3 | 4 | 1.3.1 |
| | (d) | Ratio of the sliding to rolling velocity at the<br>(i) beginning of contact.<br>(ii) pitch point.<br>(iii) end of contact. | 3 | L3 | 4 | 1.3.1 |
| | | **OR** | | | | |
| VIII. | (a) | Compare the cycloidal and involute form of teeth to justify why the use of involute teeth have become almost universal rendering cycloidal system obsolete. | 5 | L2 | 4 | 1.3.1 |
| | (b) | State what interference in involute gears is and determine the minimum number of teeth on each wheel to avoid interference in the below case. Two 20° involute spur gears mesh externally and give a velocity ratio of 3. The module is 3 mm and the addendum is equal to 1 module. The pinion rotates at 120 rpm. | 5 | L3 | 4 | 1.3.1 |
| | (c) | Determine the contact ratio. | 5 | L3 | 4 | 1.3.1 |
| IX. | | Prove the following statements. | | | | |
| | (a) | Centrifugal tension depends only on the velocity of the belt over the pulley. | 4 | L3 | 5 | 1.3.1 |
| | (b) | Power transmitted by a belt drive is reduced if centrifugal effect is considered for a given value of the total tight side tension T. | 3 | L3 | 5 | 1.3.1 |
| | (c) | 2 kW of power is transmitted by an open-belt drive. The linear velocity of the belt is 2.5 m/s. The angle of lap on the smaller pulley is 165°. The coefficient of friction is 0.3. Determine the effect of power transmission in the following cases. Initial tension in the belt is increased by 8%. | 2 | L3 | 5 | 1.3.1 |

| | | | Marks | BL | CO | PI |
|---|---|---|---|---|---|---|
| | (d) | Initial tension in the belt is decreased by 8%. | 2 | L3 | 5 | 1.3.1 |
| | (e) | Angle of lap is increases by 8% by the use of an idler pulley, for the same speed and the tension on the tight side. | 2 | L3 | 5 | 1.3.1 |
| | (f) | Coefficient of friction is increased by 8% by suitable dressing to the friction surface of the belt. | 2 | L3 | 5 | 1.3.1 |
| | | **OR** | | | | |
| X. | (a) | With neat sketches explain the working of Prony brake dynamometer and a Rope brake dynamometer. | 6 | L2 | 5 | 1.3.1 |
| | (b) | Two block brakes are shown in figures. The diameter of the brake drum in each case is 1m. Each brake sustains 240 Nm of torque at 400 rpm. The coefficient of friction is 0.32. Determine the required force to be applied when the angle of contact in the two cases are 35° and 100°. Assume the rotation of the drum to be both clockwise and counter-clockwise. | 7 | L4 | 5 | 1.3.1 |




(a)




(b)

| | | | | | | |
|---|---|---|---|---|---|---|
| | (c) | Also find the new value of c for self-locking of the brake. | 2 | L3 | 5 | 1.3.1 |

Bloom's Taxonomy Levels
L1 -3.33 %, L2 – 27.33%, L3-38.67%, L4-30.67 %,

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