



ANIPAL

ANIPAL INSTITUTE OF TECHNOLOGY

IV SEMESTER B.TECH. (MECHATRONICS ENGINEERING) END SEMESTER EXAMINATIONS, APRIL/MAY 2018

SUBJECT: THEORY OF MACHINES [MTE 2201]

[REVISED CREDIT SYSTEM]

Time: 3 Hours

MAX. MARKS:

Instructions to Candidates:

- ✤ Answer ALL the questions.
- ✤ Missing data may be suitable assumed with justification.
- 1A. Determine the number of links, binary joints, higher pairs and calculate the degree/s of (8) freedom of planar linkages shown in figures Q1A-i, Q1A-ii, Q1A-iii and Q1A-iv.



In crank and slotted lever quick return mechanism, shown in figure Q1B. P1 and P2 are two **1B.** (2) extreme positions of slotted bar, calculate the ratio of time taken in cutting to time taken during return.



Fig Q1B

2A Determine the links which forms a 4 bar mechanism in figure Q 2A (a) and Q2A (b) and determine the kind of 4 bar mechanism they are, according to Grashoff's Law.



AE = 1m, AF =0.5m, AB = 1.2m, BD = 0.5m, EC = .25m, FC = 0.8m (3)

Figure 2A (a)



 $O_4 O_6 = 1.00$, AB = 2.48, $L_2 = 1.556$, $L_4 = 2.125$, $L_6 = 1.542$, DB = 3.725, CD = 2.158.

Figure 2A (b)

2B. Which inversion of double slider forms Oldham coupling and what is the major difference (2) between Oldham coupling and hook's joint from application point of view?

- 2C. Draw the cam profile with least radius of 30 mm having a knife edge follower which (5) undergoes a lift of 30 mm. in parabolic motion for 120° followed by 30° dwell period. The follower descents for next 90° with SHM when the cam shaft have velocity of 800 RPM counter clockwise.
- **3A.** What is the necessity of differential gear in an automobile? How does it function?
- **3B.** In the figure Q 3B given below, bar O_2 A rotates with angular velocity 10 rad/s about O_2 in (4) clockwise direction accelerating at 0.5 rad/s² angular acceleration. If angular velocities of link O_4 B and AD are 7.8 rad/s and 4.6 rad/s. Calculate angular acceleration of point P and link BO₄ when $\theta = 110^{\circ}$ (All the dimensions are in meters).



3C. Gear 2 rotates at 1200 rpm in counter clockwise direction and engages with Gear 3. Gear 3 and Gear 4 are mounted on the same shaft. Gear 5 engages with Gear 4. The numbers of teeth on Gears 2, 3, 4 and 5 are 20, 40, 15 and 30, respectively. Find angular speed of Gear 5.





- **4A.** What are the differences between couple unbalance and quasi-static unbalance from (3) geometric and vibration point of view? Support your answer with rough sketch.
- **4B.** What is Interference of Involute gears? Suggest two methods to avoid it.
- (2) (5)

(3)

4C. For a compound planetary gear (Gear 3 and Gear 4) train shown in Fig Q 4C the data for number of teeth and input velocities (rad/s) is given below.
(i) Calculate the angular velocity of gear 2 if ω₆=20rad/s and ω_{arm}=30 rad/s
(ii) What should be the angular velocity of Arm in order to get angular velocity of gear 2 as 50 rad/s clockwise, keeping annular wheel 6 fix.

 $T_2 = 30 \qquad T_3 = 25 \qquad T_4 = 45 \qquad T_5 = 50 \qquad T_6 = 200$



Figure Q 4C

5A. Figure Q 5A shows a system with three weights on a rotating shaft. Mass 1 is 9 kg at 90° at a 4 cm radius, mass 2 is 9 kg at 225° at a 6 cm radius and mass 3 is 6 kg at 315° at a 10 cm radius. Determine the magnitude and angles of the balance weights needed to dynamically balance the system. The balance weights in planes 4 and 5 are placed at 3 cm radius each. (all dimensions are in cm)



Figure Q5A

- 5B. A single plate clutch, effective on both sides, is required to transmit 25kW at 3000 rpm. (2) Determine the outer and inner radii of frictional surface if the coefficient of friction is 0.255, the ratio of radii is 1.25 and the maximum pressure is not to exceed 0.1 N/mm². Also determine the axial thrust to be provided by springs. Assume the theory of uniform wear.
- 5C. Two identical gears are in mesh, what is the smallest number of teeth that can be used on each of two equal gears to avoid interference, if pressure angle is 14.5°. Calculate Path of contact, arc of contact and contact ratio if diametral pitch is 0.2.