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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

DEPARTMENT OF MECHATRONICS

IV SEMESTER B.TECH. MECHATRONICS

END SEMESTER EXAMINATION, APRIL - MAY 2024

SUBJECT: THEORY OF MACHINES [MTE 2221]

(03/05/2024)

Time: 3 Hours   MAX. MARKS: 50

Instructions to Candidates:
- ❖ Answer **ALL** the questions.
- ❖ Data not provided may be suitable assumed.

Q. No		M	CO	PO	LO	BL
1A.	Classify the kinematic pairs according to nature of mechanical constraint.	2	1	1	1	L2
1B.	The following are particular of pair of spur gears. Number of teeth on pinion (Driving) = 19. Number of teeth on gear (Driven) = 47. Pressure angle = 20 degree. Module 6.5mm, Addendum = 6.5 mm. Determine i) number of pairs of teeth in contact ii)ratio of velocity of sliding to rolling velocity, when pinion tooth tip touches the gear flank	4	4	2	2	L4
1C.	Analyse the inversion obtained by fixing the link 2 of slider crank chain which has application in workshops to cut metals. Draw relevant sketch. (In a basic slider crank mechanism link 1 represents frame, link 2 crank, link 3 connecting rod and link 4 is slider)	4	1	2	2	L3
2A.	The velocity ratio of two spur gears in mesh is 0.4 and the centre distance is about 75mm. For a module of 1.2 mm, find the number of teeth of the gears. Also find exact centre distance between them.	2	4	2	2	L4
2B	Design a slider crank mechanism to coordinate three positions of the input and of the slider for the following data by inversion methods: - $\theta_{12} = 30º$; $\theta_{23} = 30º$; $S_{12} = 40$ mm; $S_{23} = 56$ mm. Eccentricity = 20 mm	3	2	2	3	L4
2C	In a four bar chain ABCD has a fixed link AD = 1m. The driving crank AB = 0.3m. The follower link CD = 0.6m and the connecting link BC = 1.2m. Find the velocity and acceleration of point P midway between B and C, when angle BAD = 135 degree and AB rotates clockwise at a speed of 300 rpm with an angular acceleration of 20 rad/sec^2 in counter clockwise direction.(Use Graphical Method, Write Graph	5	2	3	3,4	L4

	sheet No in EPAD, Show all calculation in EPAD, and diagram in Graph sheet)					
3A	Prove that in a pair of gears are in mesh, the velocity of sliding is proportional to the distance of the point of contact from the pitch point	2	4	1	2	L3
3B	A punching press is required to punch 40 mm dia. holes in a plate of 15 mm thick at the rate of 30 holes per minute. It requires 6 Nm of energy per mm^2 of sheared area. If the punching takes $1/10^{th}$ of second and the rpm of the flywheel varies from 160 to 140 rpm, determine the mass of the flywheel having radius of gyration of 1 meter.	3	3	2	3	L4
3C	A shaft carries four masses 'A', 'B', 'C' and 'D', 200, 300, 240 and 360 kg respectively, revolving at radii 90, 70, 100, 120 mm respectively. The distance from the plane A are 270 mm, 420mm and 720 mm respectively. Angle between the crank 'A' and 'B' is 45 degree, 'B' and 'C' is 75 degree, and 'C' and 'D' is 130 degree. Balancing masses are placed 120 mm and 100 mm from 'D' and 'A' respectively. The distance between them being 500 mm. Find the balancing masses and their angular position if they are placed at a radius of 100mm. (Use Graphical Method, Write Graph sheet No in EPAD, Show all calculation in EPAD, and diagram in Graph sheet)	5	3	3	2,3	L4
4A	In case of Cam, Differentiate between i) base circle and prime circle ii) trace point and pitch point	2	5	1	1	L2
4B	In a four bar kinematic chain, link PQ=8cm, PS=3cm, RS=12cm and QR=10cm. Does it satisfies Grashof's law?? Find all the inversions of this kinematic chain.	3	1	2	2	L3
4C	In an Epicyclic gear train, the internal wheels A and B, and the compound wheels C and D rotate independently about axis O. The wheels E and F rotate on pins fixed to the arm G. E gears with A and C and F gears with B and D. All wheels have the same module and number of teeth are $T_A = 64$; $T_B = 62$; $T_E = T_F = 18$. a) Sketch the arrangement b) If arm G makes 100 rpm clockwise and A is fixed, find speed of B c) If arm G makes 100 rpm clockwise and wheel A makes 10 rpm counter clockwise, find the speed of wheel B.	5	4	3	4	L4
5A	A Cam with 30 mm minimum radius is rotating clockwise at a uniform speed of 800 rpm and has to give the motion to the roller follower as defined below. Follower to move outward through 30 mm during 120 degree of Cam rotation with uniform acceleration and deceleration motion Dwell for the next 30 degree Follower to return to its starting position during the next 90 degree with SHM Dwell for the remaining period. If the roller diameter is 15 mm, calculate maximum velocity and acceleration during ascent and descent.	2	5	2	2	L4

5B	An epicyclic gear train consists of an arm and two gears A and B having 32 and 48 teeth respectively. The arm rotates about the centre of the gear A at a speed of 120 rpm counter clockwise. Determine the speed of the gear B if i) the gear A is fixed and ii) the gear A revolves at 240 rpm clockwise instead of being fixed.	3	4	2	3	L4
5C	A Cam with 3 cm as minimum radius is rotating clockwise at a uniform speed of 1200 rpm and has to give the motion to the knife edge follower as defined below. Follower to move outward through 3cm during 120 degree of Cam rotation with SHM Dwell for the next 60 degree Follower to return to its starting position during the next 90 degree with uniform acceleration and deceleration motion Dwell for the remaining period. Draw the Cam profile.	5	5	3	4	L4

L1 – Remembering, L2 – Understanding, L3 - Applying, L4 – Analyzing, L5 – Evaluating, L6 - Creating