MECHANICAL

DEPARTMENT

2022-23

TOM

PREPARED BY

ABHISHEK SHARMA

Techno India NJR Institute of Technology

Course File

Session 2022-23

TOM (4ME-07)

Abhishek Sharma
(Assistant Professor)
Department of ME

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

2nd Year - IV Semester: B.Tech. : Mechanical Engineering

4ME4-07: THEORY OF MACHINES

Credit: 4 **Max. Marks: 200 (IA:40, ETE:160)**

3L+1T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Introduction to mechanism: Basic concept of machines, links, kinematic pair, kinematic chain and mechanism. Inversions of kinematic chains: four bar chain mechanisms, quick return mechanisms, inversions of double slider crank mechanisms.	4
	Velocity and acceleration in mechanism: Velocity and acceleration polygons, relative velocity and instantaneous centre method	3
3	Friction devices: Types and laws of friction. Pivots and collars. Power screws such as lead screw of the lathe.	3
	Clutches: Single and multi-plate clutches. Brakes: Band, block and band and block brakes.	4
4	Gears: Laws of gearing, gears terminology; tooth form; interference, undercutting and minimum number of teeth on pinion. Rack and pinion, Spur, helical, basic introduction of bevel, worm and worm gears.	6
	Gear Trains: Simple, compound and epicyclic gear trains.	3
5	Cams: Type of cams; displacement, velocity and acceleration curves for different cam followers; consideration of pressure angle and wear.	4
	Gyroscope: Principles of gyroscopic couple, effect of gyroscopic couple and centrifugal force on vehicles taking a turn, stabilization of ship.	4
6	Balancing: Balancing of rotating masses in same and different planes, balancing of reciprocating masses, swaying couple, hammer blow and tractive effort.	7
	TOTAL	39

Course Overview:

To introduce the approaches and mathematical models used in kinematic and dynamic analysis of machinery. To give basic knowledge on kinematic and dynamic design of machinery. To give basic knowledge on mechanical vibrations.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Analysis	Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms.
2	Synthesis	Analyze the planar mechanisms for position, velocity and acceleration.
3	Synthesis	Synthesize planar four bars and slider crank mechanisms for specified kinematic conditions.
4	Synthesis	Evaluate gear tooth geometry and select appropriate gears for the required applications.
5	Synthesis	Design cams and followers for specified motion profiles.

Prerequisites:

1. Basic Knowledge about Free Body Diagram
2. Must have completed the course on Engineering Mechanics.

Course Scheme -

Teaching & Examination Scheme

B.Tech. : Mechanical Engineering
2nd Year - IV Semester

SN	Category	Course Code	Course Title	Contact hrs/week L	T	P	Marks Exm Hrs	IA	ETE	Total	Cr
THEORY											
1	BSC	4ME2-01	Data analytics	2	0	0	2	20	80	**100**	**2**
2	HSMC	4ME1-03/ 4ME1-02	Managerial Economics and Financial Accounting/ Technical Communications	2	0	0	2	20	80	**100**	**2**
3	ESC	4ME3-04	Digital Electronics	2	0	0	2	20	80	**100**	**2**
4	PCC	4ME4-05	Fluid Mechanics and Fluid Machines	3	1	0	3	40	160	**200**	**4**
5	PCC	4ME4-06	Manufacturing Processes	3	0	0	3	30	120	**150**	**3**
6		4ME4-07	Theory of machines	3	1	0	3	40	160	**200**	**4**
			Sub Total	15	2	0		170	680	**850**	**17**
PRACTICAL & SESSIONAL											
7	PCC	4ME3-21	Digital Electronics lab	0	0	3		45	30	**75**	**1.5**
8	PCC	4ME4-22	Fluid Mechanics lab	0	0	3		45	30	**75**	**1.5**
9	PCC	4ME4-23	Production practice lab	0	0	3		45	30	**75**	**1.5**
10	PCC	4ME4-24	Theory of machines Lab	0	0	3		45	30	**75**	**1.5**
11	SODECA	4ME8-00	Social Outreach, Discipline & Extra Curricular Activities	0	0	0		0	0	**25**	**0.5**
			Sub- Total	0	0	12		180	120	**325**	**6.5**
			TOTAL OF IV SEMESTER	15	2	12		350	800	**1175**	**23.5**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*

ETE: *End Term Exam,* ***IA:*** *Internal Assessment*

Course Outcome Mapping with Program Outcome:

Theory of Machines Year of study: 2021-22															
Course Outcome	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	3	1	2	1	1	2	2	0	1	2	1	1
CO2	1	1	1	2	1	1	0	0	1	1	0	1	2	2	1
CO3	3	2	3	2	2	0	0	0	0	1	0	1	3	2	2
C04	3	1	1	1	1	0	0	0	0	1	0	0	2	1	1
C05	1	0	1	2	0	0	0	0	1	0	0	0	2	1	1
Average	2.00	1.20	1.40	2.00	1.00	0.60	0.20	0.20	0.80	1.00	0.00	0.60	2.20	1.40	1.20

Course Coverage Module Wise:

Lecture No.	**Unit**	**Topic**
1	**1**	**INTRODUCTION:** Objective, scope and outcome of the course
2	**2**	**INTRODUCTION TO MECHANISM**: Basic concept of machines, links.
3	2	Kinematic pair, kinematic chain
4	2	Mechanism. Inversions of kinematic chains: four bar chain mechanisms.
5	2	Inversions of kinematic chains: Single slider mechanisms.
6	2	Inversions of kinematic chains: Single slider mechanisms.
7	2	inversions of double slider crank mechanisms.
8	2	Velocity Diagram or polygons..
9	2	Acceleration Diagram or polygons.

10	2	Relative velocity and instantaneous centre method
11	**3**	**FRICTION DEVICES**: Types and laws of friction
12	3	Pivots and collars
13	3	Power screws such as lead screw of the lathe.
14	3	Clutches: Single -plate clutches.
15	3	multi-plate clutches.

16	3	Brakes: Band brake and numerical problem.
17	3	Block brake and numerical problem.
18	3	band and block brakes and numerical problem.
19	**4**	**GEARS:** Introduction, classification of gear
20	4	Gears: Laws of gearing
21	4	gears terminology; tooth form of gear.
22	4	Tooth form : Involutes Profile.
23	4	interference, undercutting and minimum number of teeth on pinion
24	4	interference, undercutting and minimum number of teeth on gear.
25	4	interference, undercutting and minimum number of teeth on Rack and pinion.

26	4	Length of path contact, Length of arc of contact and contact ratio.
27	4	Spur, helical, basic introduction of bevel,
28	4	Worm and worm gears.
29	4	Gear Trains: Simple, compound
30	4	Gear Trains : Reverted Gear train
31	4	Gear Trains : epicyclic gear trains.
32	5	**CAMS:** Introduction and Type of cams
33	5	Cams: displacement, velocity and acceleration curves for Knife edge follower.
34	5	Cams: displacement, velocity and acceleration curves for roller follower.
35	5	Cams: displacement, velocity and acceleration curves for flat follower.
36	5	Gyroscope: Principles of gyroscopic couple.
37	5	Effect of gyroscopic couple and centrifugal force on two wheel vehicles taking a turn.
38	5	Effect of gyroscopic couple and centrifugal force on four wheel vehicles taking a turn.stabilization of ship.
39	6	**BALANCING:** Balancing of rotating masses in same
40	6	Balancing: Balancing of rotating masses in different planes
41	**6**	Balancing of reciprocating masses,

42	6	Swaying couple, hammer blow and tractive effort.

TEXT/REFERENCE BOOKS

1. RATTAN, S.S., “THEORY OF MACHINES”, 2ND ED., TATA MCGRAW HILL

2. BEVAN, T., “THEORY OF MACHINES”, PEARSON EDUCATION.

Teaching and Learning resources:

- **MOOC (NPTEL): -** https://drive.google.com/drive/u/1/folders/1gimy5aZo207_Oja05Hw6JE2qNjyotPOz.

  YouTube Videos Link – https://www.youtube.com/c/TECHNICALCLASSES_TC

- **Assessment Methodology:**

1. Two Midterm exams where student have to showcase subjective learning.
2. Final Exam (subjective paper) at the end of the semester.
3. Surprise Test

Last Year Paper.

Total No of Pages: 4

4E1235

Roll No. _____

4E1235

B. Tech. IV-Sem. (Back) Exam., Oct.-Nov. - 2020

Automobile Engineering

4AE4 – 07 Theory of Machines

AE, ME

Time: 2 Hours **Maximum Marks: 110**

Min. Passing Marks: 39

Instructions to Candidates:

Attempt all ten questions from Part A, four questions out of seven questions from Part B and two questions out of five from Part C.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used /calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL 2. NIL

PART – A

(Answer should be given up to 25 words only) **[10×3=30]**

All questions are compulsory

Q.1 Define kinematic pair.

Q.2 Explain Lower pair and higher pair.

Q.3 What is Angle of Repose?

Q.4 Write the function of clutch.

Q.5 State the law of gearing.

Q.6 What are the functions of differential?

Q.7 What do you understand by gyroscopic couple?

Q.8 Name the different types of motion with which a following can move?

Q.9 Explain swaying couple.

Q.10 What are in-line engines?

PART – C

(Descriptive/Analytical/Problem Solving/Design Questions) **[2×20=40]**

Attempt any two questions

Q.1 In a slider – crank mechanism, the crank is 480 mm long and rotates at 20 rad/sec. in the counter – clockwise direction. The length of the connecting rod is 1.6 m, when the crank turns 60° from the IDC, determine –

(a) The velocity of the slider

(b) The velocity of point E located at a distance 450mm on the connecting rod extended.

(c) The angular velocity of the connecting rod.

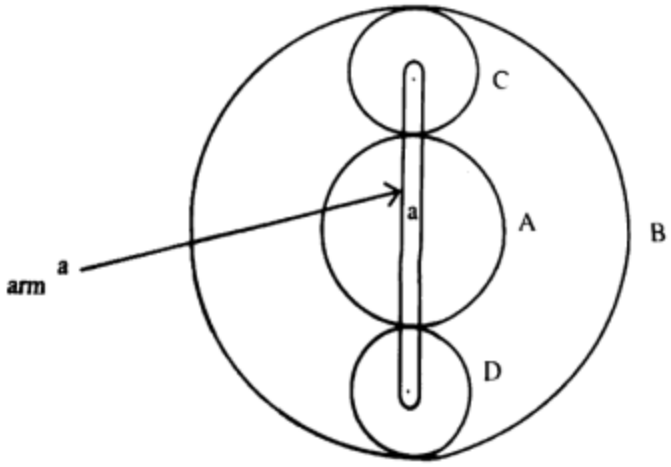
(d) The velocity of rubbing at the crank pin.

Q.2 If the capacity of a single plate clutch decreases by 13% during the initial wear period, determine the minimum value of the ratio of internal diameter to external diameter for the same axial load. Consider both the sides of the clutch plate to be effective.

Q.3 An epicyclic gear train is shown in fig. The number of teeth on A and B are 80 and 200. Determine the speed of the arm a.

(a) If A rotates at 100 rpm clockwise and B at 50 rpm counter – clockwise.

(b) If A rotates at 100 rpm clockwise and B is stationary.



PART – B

(Analytical/Problem solving questions) **[4×10=40]**

Attempt any four questions

Q.1 Sketch and explain the various inversions of a four bar chain.

Q.2 Derive an expression for efficiency of a square thread.

Q.3 A single plate clutch is required to transmit 8 kW at 1000 rpm. The axial pressure is limited to 70 kN/m^2. The mean radius of the plate is 4.5 times the radial width of the friction surface. If both the sides of the plate are effective and the coefficient of friction is 0.25, find –

(a) The inner and outer radii of the plate

(b) The friction of the friction lining

Q.4 Derive the expression of minimum number of teeth on a pinion to avoid interference.

Q.5 Deduce expressions for the velocity and acceleration of the follower when it moves with simple harmonic motion.

Q.6 Discuss the gyroscopic effect on sea vessels.

Q.7 The following data relate to a single-cylinder reciprocating engine –

Mass of reciprocating parts = 40kg

Mass of revolving parts = 30 kg at crank radius

Speed = 150 rpm

Stroke = 350 mm

If 60% of the reciprocating parts and all the revolving parts are to be balanced, determine-

(a) The balance mass required at radius 320 mm.

(b) The unbalanced force when the crank has turned 45° from TDC.

Q.4 Draw the profile of a cam operating a knife – edge follower having a lift of 30 mm. The cam raises the follower with SHM for 150° of the rotation followed by a period of dwell for 60°. The follower descends for the next 100° rotation of the cam with uniform velocity, again followed by a dwell period. The cam rotates at a uniform velocity of 120 rpm and has a least radius of 20mm. What will be the maximum velocity and acceleration of the follower during the lift and the return.

Q.5 Deduce expressions for variation in tractive force, swaying couple and hammer blow for an uncoupled two cylinder locomotive engine.

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5E6202

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5E6202

B.Tech. V - Semester (Back) Examination, Nov. - 2019
Mechanical Engg.
5ME2A Dynamics of Machines
(Common for ME, AE)

Time : 3 Hours **Maximum Marks : 80**
Min. Passing Marks : 26

Instructions to Candidates:

*Attempt any **five** questions, selecting **one** question from each unit. All questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly). Units of quantities used / calculated must be stated clearly.*

UNIT - I

1. What is the function of a governor? Explain the Porter and Hartnell governors with neat sketches. **(16)**

(OR)

1. a) Explain the terms and derive expressions for 'effort' and 'power' of a Porter governor with neat sketches. **(10)**

b) How does governor differ from that of a flywheel? **(6)**

UNIT -II

2. Describe the gyroscopic effect on a sea going vessel during steering, pitching and rolling with neat sketches. **(16)**

(OR)

2. What do you mean by gyroscopic effect? Explain the effect of the gyroscopic couple on the reaction of the four wheels of a vehicle negotiating a curve with neat sketches. **(16)**

UNIT - III

3. Explain the terminologies of a gear. Also discuss the difference between cycloidal and involute profile of gears. **(16)**

(OR)

3. Two mating involute spur gear of 20° pressure angle have a gear ratio of 2. The number of teeth on the pinion is 20 and its speed is 250 r.p.m. The module pitch of the teeth is 12 mm. If the addendum on each wheel is such that the path of approach and the path of recess on each side are half the maximum possible length, find: 1. the addendum for pinion and gear wheel; 2. the length of the arc of contact; and 3. the maximum velocity of sliding during approach and recess. Assume pinion to be the driver. **(16)**

UNIT -IV

4. a) Discuss various types of gear trains. **(8)**

   b) Explain the application of epicyclic gear train in differential gear of an automobile. **(8)**

(OR)

4. Write a short note on followings (any two): **(2×8)**

   i) Sliding mesh gear box

   ii) Constant mesh gear box

   iii) Synchromesh gear box

UNIT-V

5. a) Explain the balancing of different masses revolving in the same plane. **(6)**

   b) A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions. **(10)**

(OR)

5. Derive the following expressions, for an uncoupled two cylinder locomotive engine:

   i) Variation is tractive force; **(6)**

   ii) Swaying couple; and **(6)**

   iii) Hammer blow. **(4)**

5E6202

Roll No. :.

Total Printed Pages : 3

5E6202

B. Tech. (Sem. V) (Mercy Back) Examination, November 2018
Mechanical Engineering
5ME2A Dynamics of Machines (AE, ME)

Time : 3 Hours

Maximum Marks : 80
Min. Passing Marks : 24

*Attempt any **five** questions, selecting **one question** from **each unit**. All questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.*

Use of following supporting material is permitted during examination. (Mentioned in form No. 205) http://www.rtuonline.com

1. NIL 2. NIL

UNIT - I

1 (a) Classify Governors in various categories. 6

(b) Derive the relationship between Height of the Governor and its speed for a proell Governor. 10

OR

1 Define any two terms :

(i) Sensitiveness

(ii) Isochronism and stability of Governor

(iii) Hunting of Governor. 8×2=16

UNIT - II

2 (a) Discuss the effect of the Governor couple on a two wheeled vehicle taking a turn.

8

(b) Derive an expression for the angular acceleration of the connecting rod of a Reciprocating engine.

8

OR

2 An aeroplane flying with the speed of 200 km/hr turns towards right and completes a quarter circle of 50 m radius. The mass of the rotary engine and the propeller of the plane amounts to 400 kg with a radius of gyration of 300 mt. The engine speed is 1500 rpm. clockwise when viewed from the front. Determine the gyroscopic couple on the air craft and state its effect. In what way the effect changed when the aeroplane turns towards left ?

16

UNIT - III

3 (a) With the help of a neat sketch derive the condition for minimum no. of teeth on wheel to avoid interference.

10

(b) What do mean by undercutting of Gears ?

6

OR

3 A pinion of 32 involute teeth and 4 mm module driver a rack. The pressure angle is 20°. the Addendum of both pinion and of the Addendum to avoid interference. Also find the number of pairs of teeth in contact.

16

UNIT - IV

4 (a) Explain the working of a sliding mesh gear box. 8

(b) Discuss the speed ratio of a compound gear train. 8

OR

4 Draw a neat sketch of sun and planet gear arrangement. Using tabular method derive the expression for speed of arm when sun wheel is fixed and when annular wheel is fixed respectively. http://www.rtuonline.com 16

UNIT - V

5 (a) Explain the effect of partial balancing in locomotives. 8

(b) Describe any one type of static balancing machine. 8

OR

5 The axis of a three-cylinder air compressor are at 120° to one another and their connecting rods are coupled to a single crank. The length of each connecting rod is 240 mm and the stroke is 160 mm. The reciprocating parts have a mass of 2.4 kg per cylinder. Determine the primary and secondary forces if the engine runs at 2000 rpm. http://www.rtuonline.com 16