

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: THEORY OF MACHINES  
(Code: 3341903)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
<b>Mechanical Engineering, Mechatronics Engineering</b>	<b>4<sup>th</sup> Semester</b>

**1. RATIONALE**

In industries, the mechanical engineers/technicians are supposed to manage functioning of equipment with proper planning, operation and maintenance of equipment. Such a functional requirement needs knowledge and skills of various motion and force transforming mechanisms and devices, such as four bar mechanism, belt pulley, clutches, flywheel, etc. This course is included in the curriculum to provide such necessary knowledge and skills in the area of mechanical equipment and devices to help in understanding of kinematics & dynamics of different equipment being used in industry. Thus it is a key course for mechanical engineers/technicians.

**2. COMPETENCY**

The course content should be taught with the aim to develop different types of skills so that students are able to acquire following competency:

- **Use principles of kinematics and dynamics in operation and maintenance of various mechanisms and equipments.**

**3. COURSE OUTCOMES**

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Draw inversions and determine velocity and acceleration of different mechanisms.
- Construct different types of cam profile for a given data.
- Calculate loss of power due to friction in various machine elements.
- Solve problems on power transmission.
- Construct turning moment diagram.
- Calculate balancing mass and its position.
- Identify different types of vibration, their causes and remedies.

**4. TEACHING AND EXAMINATION SCHEME**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE	PA	ESE	PA	
4	0	2	6	70	30	20	30	<b>150</b>

**Legends:** L -Lecture; T -Tutorial/Teacher Guided Student Activity; P -Practical; C - Credit; ESE-End Semester Examination; PA -Progressive Assessment.

## 5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I</b> <b>Introduction</b>	1a. Define link, pairs, mechanisms, inversion, structure and machines. 1b. Explain various terminology associated with theory of machine.	1.1 Theory of machines: introduction, need, scope and importance in design and analysis. 1.2 Kinematics, kinetics and dynamics- concept and examples. 1.3 Basic terminology related to machines and mechanisms.
	1c. Draw inversions of different mechanisms	1.4 Development of different mechanisms and its inversions like four bar chain mechanism, slider crank mechanism, double slider crank mechanism, etc.
<b>Unit – II</b> <b>Velocity and acceleration diagram</b>	2a. Draw velocity and acceleration diagram for a given mechanism. 2b. Calculate velocity and acceleration from a given mechanism.	2.1 Basic concept used in solving velocity and acceleration problems. 2.2 Approach to solve velocity and acceleration related to mechanisms using Relative velocity method for single slider crank mechanism and Four bar chain mechanism. 2.3 Klein's construction for single slider cranks mechanism.
<b>Unit – III</b> <b>Cam and cam profile</b>	3a. Explain different types of cams and cam followers and their motions.	3.1 Introduction, functions and types of cams and cam followers. 3.2 Types of motions and displacement for different types of cam and cam followers.
	3b. Construct different types of cam profile from given data.	3.3 Construct different types of cam profiles.
<b>Unit – IV</b> <b>Friction</b>	4a. Explain laws of friction 4b. Calculate Power loss due to friction in bearings.	4.1 Concept and laws of friction. 4.2 Appreciate the role of friction in thrust bearing, pivot bearing and collars considering - Uniform pressure and Uniform wear condition.
	4c. Describe the working of different types of clutches, brakes and dynamometers.	4.3 Clutch: i. Functions. ii. Types with sketches and working. 4.4 Brakes: i. Functions. ii. Types with sketches and working. 4.5 Dynamometers- types and operational working principles.

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – V</b> <b>Power transmission</b>	5a.Explain the need and modes of power transmission.	5.1 Introduction, need and modes of power transmission. 5.2 Types of power transmission.
	5b.Solve problems on flat belt drive.	5.3 Belt drive- types, terminology and standards/designation methods as per BIS/ISO. 5.4 Belt speed-co-efficient of friction, velocity ratios and slip. 5.5 Power transmitted by flat belt - tensions, centrifugal tensions, maximum tension, condition for transmitting maximum power and initial tension.(with derivations), numerical examples. 5.6 Merits and demerits of power transmission drives.
	5c.Solve simple problems on gear trains.	5.7 Gear trains-types, numerical examples and applications.
<b>Unit – VI</b> <b>Flywheel and governor</b>	6a.Construct Turning moment diagram.	6.1 Turning moment diagram: i. Concept. ii. Its use for different machines. iii. Fluctuations of energy. 6.2 Co-efficient of fluctuation of speed and energy. 6.3 Method to construct turning moment diagram, numerical examples.
	6b.Differentiate between flywheel and governor. 6c.Calculate mass of flywheel.	6.4 Flywheel: functions and types. 6.5 Moment of inertia and mass calculation of flywheel-numerical examples. 6.6 Governors: terminology, types & functions.
<b>Unit – VI I</b> <b>Balancing and vibrations</b>	7a.Calculate balancing mass and its position for masses revolving in same plane.	7.1 Concepts and types of balancing. 7.2 Effects of unbalanced masses. 7.3 Balancing of revolving masses in same plane: i. Analytical and graphical methods to find balancing mass. ii. Numeric examples. 7.4 Balancing of reciprocating masses. (No numerical examples).
	7b.Identify different types of vibration, its causes and remedies.	7.5 Vibration: i. Terminology. ii. Effects. iii. Causes. iv. Remedies.

## 6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction	08	07	07	00	14
II	Velocity and acceleration diagram	07	02	00	05	07
III	Cam and cam profile	06	00	00	07	07
IV	Friction	12	02	05	07	14
V	Power transmission	12	00	07	07	14
VI	Flywheel and governor	06	02	05	00	07
VII	Balancing and vibrations	05	05	02	00	07
<b>Total</b>		<b>56</b>	<b>18</b>	<b>26</b>	<b>26</b>	<b>70</b>

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### General Notes:

- If midsem test is part of continuous evaluation, unit numbers I, II, III and IV (Up to 4.2 only) are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

*Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	ALL	<b>Preparatory Activity:</b> a. Interpret and write various course related SI units and their conversions. b. Recall and write scalar and vector quantities.	02

		c. Demonstrate various mechanisms.	
2	II	<b>Velocity And Acceleration:</b> <ol style="list-style-type: none"> <li>Prepare one sheet on velocity and acceleration diagram for given mechanisms by relative velocity method. This should include minimum four problems.</li> <li>Prepare one sheet on velocity and acceleration diagram for given mechanisms by Klein's construction method. Teacher will assign any one problem from sheet drawn with relative velocity method. (Above at a).</li> <li>Prepare report showing necessary calculations for above a and b.</li> </ol>	06
3	III	<b>Cam Profile:</b> <ol style="list-style-type: none"> <li>Demonstrate working of any type of cam and followers.</li> <li>Prepare one sheet on construction of cam profile for given data (without offset). This should include one problem of knife edge follower and another of roller follower.</li> <li>Prepare one sheet on construction of cam profile for given data (with offset). This should include one problem of knife edge follower and another of roller follower.</li> <li>Prepare report showing necessary calculations for above b and c.</li> </ol>	06
4	IV	<b>Demonstration of Clutch:</b> Identify different parts of a single plate disc clutch through disassembly, observe wear and tear due to friction and prepare report based on inspection criteria.	02
5	V	<b>Demonstration Of Power Transmission Systems:</b> <ol style="list-style-type: none"> <li>Identify various power transmission systems by observing different machines and equipments used in mechanical engineering laboratory/workshop. For example- IC Engine test rig, Compressors, Machine tools, Elevators, etc. Sketch at least four mechanisms with labeling on each.</li> <li>Demonstrate working of each.</li> </ol>	02
6	VII	<b>Balancing:</b> Prepare one sheet on balancing using graphical and analytical method for a given data. Include minimum two problems.	02
7	IV, V and VI	<b>Tutorials:</b> <ol style="list-style-type: none"> <li>Calculate power loss due to friction in bearings from given experimental data.</li> <li>Solve two problems of power transmission systems (one of belt drive and another of gear train) from given experimental data.</li> <li>Calculate and prepare turning moment diagram from given experimental data.</li> <li>Calculate mass of flywheel from given experimental data.</li> </ol>	02
8	ALL	<b>Mini Project And Presentation:</b> <ol style="list-style-type: none"> <li>Compile information from internet related to various mechanisms/elements like piston, crank, connecting rod, cam, clutch, brake, flywheel, governor, or animation of mechanism etc. along with functions of each.</li> <li>Select any one mechanism (preferably that which is NOT</li> </ol>	06

	<p>part of syllabus) from mechanical laboratory/workshop/real life. Sketch the same. Take photograph of the same. Also record the movie of its working.</p> <p>c. Prepare subject related mechanism simple model. This has to be proposed by student/s and has to be approved by teacher.</p> <p>d. Present the experience with power point presentation and model prepared at c above. This has to include:</p> <ol style="list-style-type: none"> <li>Compiled information as per a above.</li> <li>Explain the mechanism selected at b above. Use photographs and movie recorded.</li> <li>Explain the working of model prepared at c above.</li> <li>Photographs/movie of students working on project.</li> </ol> <p>e. Present student activities also.</p>	
	<b>Total Hours</b>	<b>28</b>

**Notes:**

- Term work report must not include any photocopies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only. However teacher may allow related photographs/movie for experience number 8.
- Term work report content of each experience should also include following.
  - Sheets, reports and tutorials.
  - Mini project model, presentation and downloaded content.
  - Student activity.
- Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 3-5 students.
- For 20 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks:
  - Problems on velocity and acceleration on mechanism, cam profile power transmission, friction, flywheel and balancing.
  - Sketch of mechanism, cam and follower, clutches, brakes, dynamometer, gear trains, governor.

**8. SUGGESTED LIST OF STUDENT ACTIVITIES**

<b>SR.NO.</b>	<b>ACTIVITY</b>
1	List the mechanisms which you are using in your day to day life. Sketch any three from these.
2.	List the mechanism used in a typical car.
3.	Identify and measure the dimensions of Flywheel used in automobile.
4.	Identify the type of clutches used in different automobiles and also the type of brakes in automobile and bicycle.
5.	Visit the market and collect the data of items which are used in any mechanisms. Data includes specifications, cost, applications, etc. Also name the mechanism/s in which such item/s is/are used.

**9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)**

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction	Model, Education charts & videos, Real life examples. Demonstration of real industrial parts used in different devices, Movies/Animations.
2	II	Velocity and acceleration diagram	Movies/Animations.
3	III	Cam and cam profile	Demonstration of cams, Movies/Animations.
4	IV	Friction	Model, Education charts & videos, Real life examples. Demonstration of real industrial parts used in different devices, Movies/Animations.
5	V	Power transmission	Demonstration of real industrial parts, Movies/Animations, Models of different power transmission elements
6	VI	Flywheel and governor	Industrial visit, Animations/movies, Models of different types of governors.
7	VII	Balancing and vibrations	Industrial visit, Animations/movies.

**10. SUGGESTED LEARNING RESOURCES****(A) List of Books:**

S. No.	Title of Books	Author	Publication
1.	Theory of Machines	Jagdishlal	Metropolitan Book New Delhi, Company, Daryaganj, Delhi.
2.	Theory of Machines	S.S.Ratan	Tata McGraw Hill , New Delhi.
3.	Theory of Machines	Abdulla Shariff	Dhanpatray and sons, New Delhi.
4.	Theory of Machines	Shah & Jadvani	Dhanpatray and sons, New Delhi.
5.	Theory of Machines	A Ghosh and AK Malik	East West Press (Pvt) Ltd., New Delhi.
6.	Theory of Machines	R.S.Khurmi	S.chand, New Delhi.
7.	Theory of Machines	P.L.Bellaney	Khanna publication, NewDelhi.
8	Theory of Machines	Joseph Edward Shigley	McGrawHill.
8	Theory of Machines	Thomas Bevan	CSB Publishers & Distributors

**(B) List of Software/Learning Websites:**

- i. <http://nptel.iitm.ac.in/video.php?subjectId=112104121>
- ii. <http://www.technologystudent.com/gears1/gears7.htm>
- iii. <http://kmoddl.library.cornell.edu/model.php?m=20>
- iv. <http://www3.ul.ie/~kirwanp/whatisacamandfollowersyste.htm>
- v. <http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Kinematics%20of%20Machine/index.htm>
- vi. [http://elearning.vtu.ac.in/12/enotes/Des\\_Mac-Ele2/Unit6-RK.pdf](http://elearning.vtu.ac.in/12/enotes/Des_Mac-Ele2/Unit6-RK.pdf)
- vii. [en.wikipedia.org/.../Canadian\\_Committee\\_for\\_the\\_Theory\\_of\\_Machines...](http://en.wikipedia.org/.../Canadian_Committee_for_the_Theory_of_Machines...)
- viii. [global.oup.com/.../theory-of-machines-and-mechanisms-978019537123...](http://global.oup.com/.../theory-of-machines-and-mechanisms-978019537123...)
- ix. [www.tecquipment.com/Theory\\_of\\_Machines.aspx](http://www.tecquipment.com/Theory_of_Machines.aspx)
- x. [www.researchgate.net/.../0094-114X\\_Mechanism\\_and\\_Machine\\_Theory](http://www.researchgate.net/.../0094-114X_Mechanism_and_Machine_Theory)
- xi. [www.journals.elsevier.com/mechanism-and-machine-theory/](http://www.journals.elsevier.com/mechanism-and-machine-theory/)
- xii. [journalseek.net/cgi-bin/journalseek/journalsearch.cgi?field=issn...](http://journalseek.net/cgi-bin/journalseek/journalsearch.cgi?field=issn...)
- xiii. [site.iugaza.edu.ps/wp-content/.../IUGAZA%20TOM2012\\_CH1-2.pdf](http://site.iugaza.edu.ps/wp-content/.../IUGAZA%20TOM2012_CH1-2.pdf)
- xiv. [www.iftomm.org/](http://www.iftomm.org/)
- xv. [www.wiziq.com/online-tests/44047-mechanical-theory-of-machine](http://www.wiziq.com/online-tests/44047-mechanical-theory-of-machine)
- xvi. [www.cs.ubc.ca/~murphyk/Teaching/CS340-Fall07/infoTheory.pdf](http://www.cs.ubc.ca/~murphyk/Teaching/CS340-Fall07/infoTheory.pdf)

**(C) List of equipments:**

- i. Working Models / wooden/thermocool theoretical models of:
  - a. Kinematic links and pairs.
  - b. Single slider crank.
  - c. Four bar chain.
- ii. Types of cams, followers and cam/follower arrangements.
- iii. Friction bearing- all types.
- iv. Dynamometers - all types.
- v. Friction clutches - all types.
- vi. Friction brakes - all types.
- vii. Rope/belt – All types of flat and vee.
- viii. Gear trains - all types.(Simple, compound, reverted, epicyclical).
- ix. Balancing machines -Revolving masses, Reciprocating masses.
- x. Steam engine, internal combustion engine.
- xi. Governors - all types.
- xii. Vibration -spring and mass model.
- xiii. Any machine having flywheel.

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics:**

- **Prof. D. M. Trivedi.** Lecturer in Mechanical Engineering, K.J.Polytechnic , Bharuch.
- **Prof. M. P. Jakhaniya,** Lecturer in Mechanical Engineering, C.U.Shah.Polytechnic Surendranagar.
- **Prof. D. R. Katariya,** Lecturer in Mechanical Engineering, Government Polytechnic, Bhuj.

**Coordinator and Faculty Members from NITTTR Bhopal.**

- **Prof. Sharad K. Pradhan**, Head, Department of Mechanical Engineering,
- **Dr. K.K. Jain**, Professor and Dean, Department of Mechanical Engineering,