Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2021-2022

Course Handout Part II

Date: 15-01-2022

In addition to part-I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Courses No. : ME F244
Course Title : Kinematics and Dynamics of Machines
Instructor-in-charge : Y V D Rao

1. **Course Description:** Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, Synthesis of mechanisms (Planer), cam design, Kinematics of gears (spur, helical, bevel and worm), gear trains, Dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes.

Academic Honesty and Integrity Policy: *Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable*

2. Scope and objective of the course:

The objective of the course is to give an insight into the basic concepts of Kinematic and Dynamic analysis of machines. The first part of the course deals with the study of kinematics of machine parts. An introduction to **Mechanisms and Machines** is given, and then **Kinematics of Mechanisms and Machines** is explained**.** Procedure for drawing **Velocity** and **Acceleration** diagrams for **Planar Mechanisms** is explained which a graphical method is basically. Use of instruments to draw these diagrams is explained. **Synthesis** of mechanisms is introduced. **Kinematics of Cam** and **Synthesis of Cam Profile** and **Toothed gearing** of spur, Helical, Bevel and worm gears are explained. Kinematics of **Gear Trains** is taught in the last chapter. In the second part, Kinetics of Machinery is dealt with under the heads: **Static force analysis**, **Dynamic force analysis** of planar mechanisms and machines, Dynamic analysis of **Reciprocating engines**, **Balancing** of Machines, **Flywheels** analysis and Design, **Governors** and **Gyroscopes**. Problems with application in these two areas will be discussed.

2. **Text books:**

(T1) Uicker J.J., Pennock G.R., Shigley J.E., "Theory of Machines and Mechanisms", Oxford Univ. Press, NY, 3rd Ed., 2003.

Reference Books:

(R1) Ghosh A., Mallik A.K., "Theory of Mechanisms and Machines", Affiliated East West Press Pvt. Ltd., New Delhi. 3rd Ed., 1998.

(R2) S S Rattan, "Theory of Machines", Tata McGraw Hill publishing Company Limited, New Delhi. 3rd Ed.

(R3) J.S Rao & R.V. Dukkipati, "Mechanisms and Machines Theory", New Age international Publishers, New Delhi, 2nd Edition,2011

3. Course Plan: Part I

Lecture No.	Objective	Topics to be Covered	Chapter in the Text Book
1 & 2	To understand the purpose of this course and its implication in the field of Engineering in particular Mechanical	Introduction to kinematics and Dynamics, terminology like Machine, Mechanism, Engine, link, rigid body, resistant body,	CH1 (TB) CH 1 (R2)

SECOND SEMESTER 2021-2022

Course Handout Part II

	Engineering.	levers	
3, 4 &5	To introduce the terminology connected with the theory of Kinematics and dynamics of mechanisms and machines.	Degree of freedom, types of kinematic joints, pairs, connections, types of links, order of links. Kinematic chains, Mechanisms, Machines, Grubler's criterion, Inversions, Grassoff's law, transmission angle, some examples on these concepts. **Creo software** use in drawing the mechanisms and understanding the motion of links.	CH1 (TB)
6, 7, 8 & 9	To understand the ways of analysis and necessity for analysis of a given mechanism and a machine and in particular study the velocity analysis using different methods of analysis.	Position and Velocity analysis of some the important mechanisms like four bar mechanism, slider crank mechanism, inversions of these two mechanisms, other mechanisms with more number of links and different kinds of pairs. Vector polygon method for velocity Analysis and Instantaneous center Method. Practice on **Auto Cad for analysis**. Numericals. **Matlab** coding for these.	CH 3 (TB)
10, 11, 12 & 13	Importance of acceleration analysis and use acceleration diagrams in the analysis.	Acceleration polygon method for acceleration Analysis including coriolis component of acceleration. Numericals and practice on **Auto CAD** for analysis. Also to use **Croe** software for the analysis.	CH 4 (TB)
14, 15, 16 & 17	Study of various transmission elements including toothed wheels and their construction details and understand the related toothed Gearing.	Different types of transmission elements including Gears, Different types of gears, their applications, manufacturing aspects, Gear Nomenclature, Law of Gearing, tooth profiles, conjugate teeth, interference, minimum number of teeth, path of contact, arc of contact, contact Ratio. Numericals.	CH6,7&8 (TB)
18 & 19	Direction of rotation, speed and torque determination for simple, compound and planetary gear systems.	Types of Gear trains, train value, speed ratio, purpose of gear trains, types of gear trains, analysis of gear trains.	CH10 (TB)
20, 21 & 22	To learn what is a Cam mechanism, to study the application of Cams. Study about the classification of Cams, motion analysis of follower; learn to draw the displacement diagram for a follower and Synthesis of cam.	Definition and applications of Cam mechanism. Classification of Cam and follower mechanisms. Displacement diagrams, Cam profile for various cases of follower motion and follower types. Analysis of cam kinematics. Use of **Auto CAD** for drawing profiles.	CH5 (TB)
23 & 24	Introduction to dynamics of Machines	Frames of Reference, Mass Moment of Inertia, Principle of Virtual Work	CH14 (TB)
25 & 26	Importance of dynamic force analysis and tools of dynamic Force Analysis	D'Alembert's Principle, Graphical Method, Use of **Auto CAD** for drawing.	CH15 (TB)

SECOND SEMESTER 2021-2022

Course Handout Part II

27 & 28	Additional tools of dynamic Force Analysis	Vector Method, Principle of Superposition	CH15 (TB)
29 & 30	Analysis of Dynamic forces in Reciprocating Engines	Introduction, Gas Forces, Dynamic Analysis, **MatLab** coding.	CH18 (TB)
31 & 32	Dynamics of Reciprocating Engines	Equivalent Masses, Inertia Forces, Crank Shaft Torque Analysis, Examples	CH18 (TB)
33 & 34	Analysis and design of Flywheels	Introduction, Flywheel Theory, Examples	CH21 (TB)
35 & 36	Theory, necessity and ways of Balancing of rotating masses in machines.	Introduction, Dynamic Unbalance, Single Plane Balancing	CH19 (TB)
37 & 38	Theory, necessity and ways of Balancing of reciprocating masses in Engines.	Multi-plane Balancing, Reciprocating Mass Balancing	CH19 (TB)
39 & 40	Theory, necessity and ways of Balancing of rotating masses in multi cylinder engines.	Multi-Cylinder Balancing, Direct and reverse crank method	CH19 (TB)
41 & 42	Theory, necessity and applications of Governors	Classification and analysis of Gravity loaded and spring loaded governors	CH22 (TB)
	Gyroscopes	Self-Study	

4. Evaluation Schedule:

Components	Duration	Weightage (%)	Date & Time	Nature of Component

SECOND SEMESTER 2021-2022

Course Handout Part II

Midsem	**90 min**	**25 (50 Marks)**	**16/03 9.00am to10.30am**	**CB**
Assignments	**120 Min**	**10 (20 Marks)**		**OB**
Tutorials	**05 Min**	**15 (30 Marks)**		**OB**
Class room surprise Quizzes	**05 min**	**10 (20 Marks)**		**OB**
Compre Exam	**120 min**	**40 (80 Marks)**	**19/05 FN**	**CB**

NB: Best 5 out of 7 surprise Quizes conducted during the regular classes will be used to evaluate for 10% of marks under Quizes head.
Best 10 out of 12 tutorial evaluations conducted during the tutorial classes will be used to evaluate for 10% of marks under Tutorials head.
10% of work will be given as 4 Assignments.

5. **Chamber consultation hour:** To be announced in the class.
6. **Tutorial classes will be conducted using AutoCAD, Creo and MatLab softwares and numericals will be solved as the case be.**
7. **Mid sem test will be using AutoCAD, Creo and MatLab softwares.**
   Students required to practice AutoCAD, Creo and MatLab softwares for the additional assignments given.
8. **Notices:** Notices concerning the course will be displayed on **Google Class Room**.
9. **Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor in Charge **ME F221**