Name of Institute : Indus Institute of Technology & Engineering
Name of Faculty : Prof. Rahul Patel (Mechanical Engineering)

Course code : ME0622
Course name : Dynamics of Machines
Pre-requisites : Kinematics of Machines
Credit points : 4
Offered Semester : VI

Subject: Dynamics of Machines (PCC)								
Program: B. Tech. (Mechanical)				Subject Code: ME0622			Semester: VI	
Teaching Scheme				Examination Evaluation Scheme				
Lecture	Tutorial	Practical	Credits	University Theory Examination	University Practical Examination	Continuous Internal Evaluation (CIE) Theory	Continuous Internal Evaluation (CIE) Practical	Total Marks
2	1	2	4	16/40	16/40	24/60	24/60	200

Course coordinator
Full name : Prof. Rahul Patel
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Telephone : 9428192514
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Consultation times : 4:30 to 5:00 (Monday to Friday)

Course lecturer
Full name : Dr. Mitesh Mungla
Department & location: Head,Department of Mechanical Engineering, Faculty Room,3rd floor,Bhanwar Building
Telephone : 9904405959
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Consultation times : 4:30 to 5:00 (Monday to Friday)

Course Objectives

By participating in and understanding all facets of this course a student will:

1. To Familiarity with common mechanisms used in machines and everyday life.
2. To design machine parts considering the dynamic situation.
3. To conduct a complete velocity, acceleration analysis of piston and connecting rod Mechanism.

Course Outcomes (CO)

Students will be able to :

1. Analyze effect of gyroscopic couple on vehicles, ships and aeroplanes.
2. Design flywheels for IC engines and punching press.
3. Apply fundamentals of dynamics analysis to various mechanical systems.
4. Demonstrate working Principles of different types of governor.
5. Analyze the theory involved in balancing of rotating and reciprocating members.
6. Understand longitudinal, transverse and torsional vibrations so as to avoid resonance.

Course Outline

UNIT-1 **[08]**

Governors

Introduction, types of governors, centrifugal governors, spring loaded governors, sensitiveness of a governor, hunting, isochronisms, stability, effort and power of a governor, controlling force.

Gyroscope

Precessional angular velocity, angular acceleration, gyroscopic couple, effect of gyroscopic couple on aeroplane, effect of gyroscopic couple on naval ships, stability of an four wheel vehicle , stability of a two wheel vehicle.

UNIT-2 **[08]**

Inertial Forces in Reciprocating Parts

Velocity and acceleration of the piston, forces on the reciprocating parts of an engine, equivalent dynamical system.

Turning Moment Diagram and Flywheel

Turning moment diagrams, fluctuation of energy and speed, coefficient of fluctuation of energy, coefficient of fluctuation of speed, energy stored in flywheel.

UNIT-3

[08]

Static Force Analysis

constraint and applied forces, static equilibrium, equilibrium of two and three force members, members with two force, equilibrium of four force members, force convection, free body diagram.

Dynamic Force Analysis

D' Alembert's Principles, equivalent of inertia force, dynamic analysis of four link mechanisms, dynamic analysis of slider crank mechanism, velocity and acceleration of piston, angular velocity and angular acceleration of connecting rod, engine force analysis, turning moment on crank shaft, dynamically equivalent system.

UNIT-4 **[08]**

Balancing
Introduction, static balancing, dynamic balancing, balancing of several rotating masses in single and in different planes. Primary and secondary unbalanced forces of reciprocating masses, Balancing of reciprocating masses, variation of tractive force, sway couple, hammer blow, balancing of inline engines.

Vibrations
Vibration terminology, Harmonic and periodic motions, Beats phenomenon, uses and effects, practical applications and current research trends, Free undamped vibrations using Newton's second law, D' Alembert's principles, Energy method, Rayleigh's method, free damped vibrations, logarithmic decrement, under damped, over damped and critically damped conditions.

Method of delivery
(Chalk & Talk, PPT, Active Learning Techniques with solving Tutorial)

Study time

Lecture/Week	Tutorial/Week	Lab/Week
02 hrs	01 hr	02 hrs

CO-PO Mapping

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	2	-	2	-	1	-	-	-	-	2	-	-
CO3	2	1	1	1	2	-	-	-	-	-	2	-
CO4	2	1	-	-	2	-	-	-	-	1	2	-
CO5	2	2		1	-	-	-	-	-	-	-	-
CO6	2	-	1	2	-	-	-	-	-	1	2	-

1-LightlyMapped 2-Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention

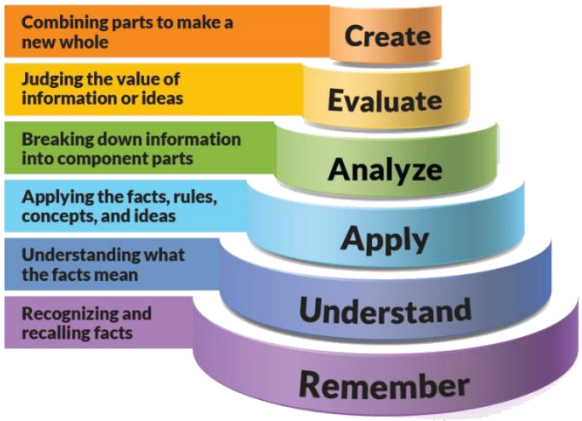

Figure 1: Blooms Taxonomy

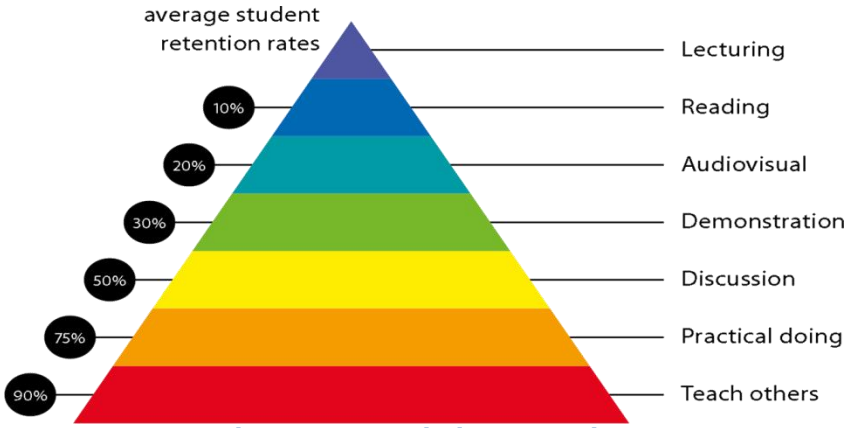

Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media.	**5 Written communication** **6 Oral communication** **7 Teamwork**

Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

1) To study Porter Governor and verify experimentally.
2) To study Proell Governor and verify experimentally.
3) To study Hartnell Governor and verify experimentally.
4) Study of Gyroscope effect and to verify experimentally.
5) To find radius of gyration of component suspended on two ends (Bifilar suspension).
6) To find radius of gyration of component suspended on three points (Trifilar Suspension).
7) To study static force analysis of a mechanism.
8) To study dynamic force analysis.
9) To study the principal method of Static and Dynamic balancing.
10) To study a longitudinal vibration of a Spring mass system

Lecture/tutorial times:(As per Time Table)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Text books

1. Shigley, J.E., and Uicker, J.J., Theory of Machines and Mechanisms, McGraw Hill International Editions, New York, Edition II, 2003.
2. Norton, R.L., Design of Machinery – An introduction to Synthesis and Analysis of Mechanisms and Machines, McGraw Hill International Editions, New York, Edition II, 2000.

Reference Books

1) Uicker,J.J. Jr., Pennock, G.R., and Shigley, J.E., Theory of Machines and Mechanisms, OxfordUniversity Press, 2009.

2) Mabie, H.H., and Reinholtz, C.F., Mechanisms and Dynamics of Machinery, 4d ed., John Wiley & sons, 1987.
3) Ghosh, A, and Mallik, A.K., Theory of Mechanisms and Machines, 3d ed., Affiliated East- West Press, 1998.
4) Holowenko, A.R., Dynamics of Machinery, John Wiley & Sons, 1965.
5) Waldron, K. J., and Kinzel,G. L., Kinematics, Dynamics and Design of Machinery, John Wiley & Sons, Inc., 2004.
6) Norton,R.L., Design of Machinery, Tata McGraw-Hill, 2004.
7) Rattan, S.S., Theory of Machines, 3d ed., Tata McGraw-Hill, 2009.
8) Nikravesh, P.E., Planar Multibody Dynamics, CRC Press, 2008.
9) Thomson, W.T., Dahleh, M.D., and Padmanabhan, C, 5d ed.,Theory of Vibrations with Applications, Pearson Education, 2008.
10) Meirovitch, L., Elements of Vibration Analysis,2d ed., McGraw-Hill, 2007.
11) Den Hartog, J.P., Mechanical Vibrations, 4d ed., McGraw-Hill, 1985.

Web resources

1. https://nptel.ac.in/courses/112104114/
2. https://nptel.ac.in/downloads/112101096/

MOOCS

1. https://onlinecourses.nptel.ac.in

ASSESSMENT GUIDELINES

1) Theory Assessment:

(a) **Continuous Internal Evaluation (CIE) - Theory - 60 Marks Bifurcation:**

Marks	Bifurcation
40 Marks	MSE
10 Marks	Assignments (Two Assignments- 05 marks each)
10 Marks	Attendance/Class Participation

(b) **ESE Theory 40 marks.**

2) Practical Assessment:

a) **Continuous Internal Evaluation (CIE) - Practical -60 Marks bifurcation:**

Marks	Bifurcation
10 Marks	Attendance/Lab Participation
30 Marks	File work
20 Marks	Practical Performance/Q & A based on Experiment

b) **ESE Practical 40 marks.**

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make they available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

Course schedule

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Week 1	**Governors** Introduction, types of governors, centrifugal governors, spring loaded governors, sensitiveness of a governor	CO 4	Chalk & Talk, Tutorial
	Week 2	hunting, isochronisms, stability, effort and power of a governor, controlling force.	CO 4	Chalk & Talk, Tutorial
	Week 3	**Gyroscope** Precessional angular velocity, angular acceleration, gyroscopic couple, effect of gyroscopic couple on aeroplane	CO 1	Chalk & Talk, Tutorial
	Week 4	effect of gyroscopic couple on naval ships, stability of an four wheel vehicle , stability of a two wheel vehicle.	CO 1	Chalk & Talk, Tutorial
	Week 5	**Inertial Forces in Reciprocating Parts** Velocity and acceleration of the piston,	CO 2	Chalk & Talk, Tutorial
	Week 6	forces on the reciprocating parts of an engine, equivalent dynamical system.	CO 2	Chalk & Talk, Tutorial
	Week 7	**Turning Moment Diagram and Flywheel** Turning moment diagrams, fluctuation of energy and speed, coefficient of fluctuation of energy,	CO 2	Chalk & Talk, Tutorial
	Week 8	coefficient of fluctuation of speed, energy stored in flywheel.	CO 2	Chalk & Talk, Tutorial
	Week 9	**Static Force Analysis** constraint and applied forces, static equilibrium, equilibrium of two and three force members,	CO 3	Chalk & Talk, Tutorial
	Week 10	members with two force, equilibrium of four force members, force convection, free body diagram.	CO 3	Chalk & Talk, Tutorial
	Week 11	**Dynamic Force Analysis** D'Alembert's Principles, equivalent of inertia force, dynamic analysis of four link mechanisms, dynamic analysis of slider crank mechanism, velocity and acceleration of piston,	CO 3	Chalk & Talk, Tutorial
	Week 12	Angular velocity and angular acceleration of connecting rod, engine force analysis, turning moment on crank shaft, dynamically equivalent system.	CO 3	Chalk & Talk, Tutorial

	Week 13	**Balancing** Introduction, static balancing, dynamic balancing, balancing of several rotating masses in single and in different planes. Primary and secondary unbalanced forces of reciprocating masses,	CO 5	Chalk & Talk, Tutorial
	Week 14	Balancing of reciprocating masses, variation of tractive force, sway couple, hammer blow, balancing of inline engines.	CO 5	Chalk & Talk, Tutorial
	Week 15	**Vibrations** Vibration terminology, Harmonic and periodic motions, Beats phenomenon, uses and effects, practical applications and current research trends, Free undamped vibrations using Newton's second law, D' Alembert's principles, Energy method, Rayleigh's method	CO 6	Chalk & Talk, Tutorial
	Week 16	free damped vibrations, logarithmic decrement, under damped, over damped and critically damped conditions.	CO 6	Chalk & Talk, Tutorial