Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information	
Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME401
Course Name	Mechanical Vibrations
Desired Prerequisites:	Engineering Mathematics, Engineering Mechanics

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To make students aware about causes and effects of the vibration on mechanical systems.
2	To discuss types of vibrations namely un-damped, damped, free and forced.
3	To elaborate the process of transmission of force and motion due to vibration.
4	To demonstrate mechanical vibration measuring instruments

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the basics of vibration, causes and basic elements and its measurement	II	Understanding
CO2	Apply numerical methods in finding natural frequency and corresponding mode shapes of systems	III	Applying
CO3	Analyze linear and torsional systems with single and two degree of freedom under free and forced vibrations, for their natural frequency and response to excitations	IV	Analyzing

Module	**Module Contents**	**Hours**
I	**Introduction** Importance and scope, Concepts and terms used, SHM, vector method of representing harmonic motions, Complex method of representing vibration, Fourier series and harmonic analysis, stiffness of springs in combinations.	7
II	**Single degree free and forced vibration: Damped and undamped** (a) Undamped free vibrations, derivation of differential equation with solution, energy method, types of damping, free vibrations with viscous damping, logarithmic decrement, coulomb damping, and damping materials. (b) Forced Vibrations: Types of excitation, forced excitation, forced vibrations with constant harmonic excitation, steady state vibration, excitation due to unbalance in machines, support excitation, response due to above types of excitations, transmissibility, force transmissibility and motion transmissibility, vibration isolators, commercial isolation materials	8

	and shock mounts	
III	**Two degree free and forced vibration** (a) Free un-damped vibrations – Principal modes and natural frequencies, co-ordinate coupling and principal co-ordinates. (b) Forced vibrations (Un damped) – Harmonic excitation, vibration, dampers and absorbers, dynamic vibration absorber – tuned and Un tuned type	7
IV	**Torsional Vibration** Natural frequency of free torsional vibrations, effect of inertia of the constraint on torsional vibrations, free torsional vibrations of a single rotor system, two rotor system and three rotor system. Torsionally equivalent shaft, free torsional vibrations of a geared system.	6
V	**Vibration Measuring Instruments** Instruments for measurement of displacement, velocity, acceleration and frequency of vibration, introduction of X – Y plotter, spectral analyzers, FFT analyzer. **Introduction to Numerical Methods in Vibration** Holzer method, Releigh's method, matrix iteration method, introduction to F. E. M., Analysis techniques used in vibration (Eigen value analysis)	6
VI	**Critical Speed of Shaft** Critical speed of a light shaft having a single disc with and without damping, Critical speeds of a shaft having multiple discs, secondary critical speeds	6

Text Books	
1	G. K. Grover, "Mechanical Vibration" Nemchand and Brothers, Roorkee, Third Edition, 2006
2	Dr. V. P. Singh, "Mechanical Vibrations", S. Chand and Sons New Delhi, Second Edition, 2004
3	J. S. Rao "Introductory Course On Theory And Practice Of Mechanical Vibrations", New Age International Publishers, Second Edition, 1999

References	
1	Austin Church, "Mechanical Vibrations", Wiley Eastern. First Edition, 1963
2	Cyril M. Harris, Charles E. Crede, "Shock and vibration handbook", McGraw-Hill, 1976
3	S. S. Rao, "Mechanical Vibrations", Fourth Edition, 2006

Useful Links	
1	Module 1 - Lecture 1 - Rigid Body Motion - YouTube
2	Introduction_old - YouTube
3	Mod-1 Lec-1 Overview of the Course, Practical and Research Trends - YouTube

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2							3					3	
CO2			1									2	2	2
CO3		1		2								3		1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment (for Theory Course)

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2022-23

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME402
Course Name	Refrigeration and Air Conditioning
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 2			

Course Objectives

1	To enable the students to analyze and solve refrigeration related problems by applying principles of mathematics, science and engineering.
2	To prepare students to use modern tools, techniques.
3	To practice effective communication skill to demonstrate refrigeration/air conditioning theories.
4	To develop skills in the analysis of refrigeration/air conditioning/cryogenics systems in research or design & industrial needs.
5	To develop a professional approach to lifelong learning in the refrigeration/air conditioning/cryogenics to include the awareness of social and environment issues.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply knowledge of mathematics, science, and engineering for the needs in refrigeration, air conditioning and cryogenic	III	Applying
CO2	Analyze different refrigeration, air conditioning and cryogenic systems with their applications.	IV	Analyzing
CO3	Evaluate refrigeration & air-conditioning systems under different conditions	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Review of Thermodynamics:** Laws, General equations, Processes, Equations applied to processes. Applications of refrigeration. **Basic Refrigeration Cycles:** Carnot cycle, Reversed Carnot cycle, Simple Vapor compression cycle, effect of sub-cooling, suction vapor superheating, Liquid to suction vapor heat exchanger, , Calculations and performance of above cycles, Actual vapor compression cycle, Bell Coleman - Reversed Bryton cycle, Air cycles for aircrafts (Descriptive Treatment).	5
II	**Multi pressure System and Refrigerants:** **Multi pressure System**	4

	Removal of flash gas, Flash inter-cooling, Water-cooling, Multistage, Multi-evaporator and Cascade System. **Refrigerants:** Classification, Desirable Properties like Thermodynamic, physical, & chemical. Comparison among commonly used refrigerants, Selection of Refrigerants, Effect on Ozone depletion and global warming, Alternative Refrigerants.	
III	**Cryogenics and Vapor Absorption System:** **Cryogenics:** Introduction to cryogenic engineering and application, liquefier and cryocoolers. **Vapor Absorption System:** Aqua Ammonia system, Enthalpy-Concentration chart. analysis of system Lithium Bromide -water vapor absorption system, Coefficient of Performance, Comparison with Vapor Compression cycle. (Descriptive treatment only).	5
IV	**Refrigeration Equipments** Types of Compressor, Condenser, Evaporator, Expansion devices, & selection, use of insulation, its types & applications...	3
V	**Psychrometry** Moist air as a working substance, Psychrometric properties of air, Use of Psychrometric tables and charts, Processes, Combinations and Calculations, ADP, Coil Condition line, Sensible heat factor, Bypass factor, Air washer and it's applications. **Comfort:** Thermal exchange between human body and environment, factors affecting comfort, effective temperature comfort chart, ventilation requirements	5
VI	**Heating and Cooling Load Calculation:** Representation of actual air conditioning process by layouts and on Psychrometric charts, load analysis, RSHF, GSHF, ESHF, Enumeration and brief explanation of the factors forming the load on refrigeration and air conditioning systems, Energy requirements of different types of air conditioning systems, Energy conservation in air conditioning.	4

	Text Books
1	C. P. Arora ,"Refrigeration and Air conditioning", Tata McGraw Hill Education Private Limited , third edition, 2008
2	Roy J. Dossat "Principle of Refrigeration", Pearson, fourth edition, 2007.
	References
1	Wilbert F. Stoecker, Industrial refrigeration handbook, 1st edition, McGraw-Hill Professional Publishing,1998
2	Wilbert F. Stoecker, Jerold W Jones ,"Refrigeration and Air Conditioning", McGraw-Hill Publishing , 2nd edition ,2008
3	Shan K. Wang, "Handbook of air conditioning and refrigeration" McGraw-Hill international second edition.
	Useful Links
1	https://nptel.ac.in/courses/112/107/112107208/
2	https://nptel.ac.in/courses/112/105/112105128/

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2												3	
CO2	2	2										1	2	2
CO3	2			2								1		2
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.														

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME403
Course Name	H-4 Legal, IPR, Safety
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	1 Hrs/Week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	15	10	25	50
		Credits: 1			

Course Objectives

1	To introduce the students about Legal, IPR, Safety laws.
2	To disseminate knowledge on patents, patent regime in India and abroad and registration aspects.
3	To be aware about current trends in IPR and Govt. steps in fostering IPR.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Understand about Indian industry Legal, IPR, Safety laws	II	Understanding
CO2	Interpret patent and copyright in innovative research work.	III	Applying
CO3	Illustrate the importance of Indian industry Legal, IPR, Safety laws.	IV	Analyzing

Contents

Module	Module Contents	Hours
1	Overview of Bureau of Indian Standards Act of 1986	2
2	The Right to Information Act of 2005, In order to promote public education and public safety	2
3	Intellectual Property, Patents, Copyrights, Trademarks,	3
4	Other forms of IP, Current Contour,	3

5	The Factories Act, 1948, The Mines Act, 1952,	2
6	The Dock Workers (Safety, Health & Welfare) Act, 1986.	1

Text Books	
1	Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2	D.S. S. Ganguly and C S Changeriya Labor & Industrial Acts & Laws (Safety Management)
References	
1	Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
Useful Links	
1	Cell for IPR Promotion and Management (http://cipam.gov.in/)
2	https://law.resource.org/pub/in/bis/manifest.med.html
3	World Intellectual Property Organization (https://www.wipo.int/about-ip/en/)
4	Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)
5	https://labour.gov.in/industrial-safety-health

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								1					1	1
CO2									2					2
CO3							1						2	

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment (for Theory Course)

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

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Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME451
Course Name	Mechanical Vibrations Lab
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	-	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To be aware about causes and effects of the vibration on mechanical systems.
2	To demonstrate mechanical vibration measuring instruments
3	To analyze types of vibrations namely un-damped, damped, free and forced vibrations.
4	To determine the transmission of force and motion due to vibration.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Demonstrate the concept of vibration, causes and basic elements and its measurement	II	Understanding
CO2	Determine natural frequency and corresponding mode shapes of systems	III	Applying
CO3	Measure force and motion transmissibility of given system	IV	Analyzing

List of Experiments / Lab Activities

List of Experiments:
Course Contents:
Any ten experiments/lab sessions from the list given below
List of experiments (study type)

1. Study of natural frequency of two degree of freedom spring mass system.
2. Study of natural frequency of double pendulum system.
3. Study of critical speed of shaft.

List of experiments (Trial / Demonstration type)

1. Determination of stiffness of spring from static deflection.
2. Determination of natural frequency of single degree of freedom spring mass system.
3. Determination of radius of gyration of compound pendulum
4. Measurement of torsional vibrations.

5. Determination of torsional vibrations of single/two rotor system.
6. Demonstration of plot response curve of system under forced vibration.
7. Determination of damping effect on a system under forced vibration with viscous damping.
8. Determination of optimal frequency for dynamic vibration absorber.
9. Measurement of various parameters of vibrations.
10. Verification of Dunkerley's rule transverse vibrations.
11. Determination of mode shapes of beam with various boundary conditions.

Text Books	
1	G. K. Grover, "Mechanical Vibration" Nemchand and Brothers, Roorkee, Third Edition, 2006
2	Dr. V. P. Singh, "Mechanical Vibrations", S. Chand and Sons New Delhi, Second Edition, 2004
3	J. S. Rao "Introductory Course On Theory And Practice Of Mechanical Vibrations", New Age International Publishers, Second Edition, 1999

References	
1	Austin Church, "Mechanical Vibrations", Wiley Eastern. First Edition, 1963
2	Cyril M. Harris, Charles E. Crede, "Shock and vibration handbook", McGraw-Hill, 1976
3	S. S. Rao, "Mechanical Vibrations", Fourth Edition, 2006

Useful Links	
1	Virtual Labs (vlabs.ac.in)
2	Hartnell Governor Practical Detailed - YouTube

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2							1					3	
CO2			3								2		2	2
CO3		3		2							1			1

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing (min 40 %), LA1+LA2 should be min 40%

Assessment	Based on	Conducted by	Typical Schedule (for 26-week Sem)	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the

nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME452
Course Name	Refrigeration & Air Conditioning Lab
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2Hrs/Week	**LA1**	**LA2**	**LA ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 1			

Course Objectives

1	To enable the students to analyze and solve refrigeration related problems by applying principles of mathematics, science and engineering.
2	To prepare students to use modern tools & techniques.
3	To train students with effective communication skill to demonstrate refrigeration/air conditioning theories.
4	To develop skills to fulfill industrial needs.
5	To develop a professional approach to lifelong learning in the refrigeration/ air conditioning /cryogenics.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Performance the experiments in refrigeration and air-conditioning as per given objectives.	III	Applying
CO2	Analyze different refrigeration, air conditioning and cryogenic systems with their applications.	IV	Analyzing
CO3	Measure the performance of different systems under different condition	V	Evaluating

List of Experiments / Lab Activities

List of Experiments:

Course Contents:

Following practical's should be considered for ISE and ESE evaluation

Experiments

1 Trial on vapour compression refrigeration system.
2 Trial on Heat Pump.
3 Trial on ice plant.
4 Trial on Cascade system.
5 Trial on air conditioning system.

Demonstration / Study

1. Study and demonstration of refrigeration system for house hold refrigerator, water cooler, ice plant and cold storage.(Industrial Visit is desirable)

2. Study and demonstration of controls in refrigeration
3. Study and demonstration on window, split & central air conditioner.
4. Study of dehydration, charging leak testing and testing of refrigeration system.
5. Study and demonstration of absorption system.
6. Study of method for star rating and EER for domestic appliances like house hold refrigerator.
7. Study of heat pump. / Vortex tube /pulse tube refrigeration.
8. Study/ Trial on multi stage compression refrigeration system.
9. Study/ trial on air washer.
10. Study/ trial on multi evaporator refrigeration system.
In case of mini-projects, drawing, presentations etc., write the relevant details of the same.

Text Books	
1	Dossat "Refrigeration", Pearson, fourth edition, 2007.
2	C. P. Arora ,"Refrigeration and Air conditioning", Tata McGraw Hill Education Private Limited , third edition,2008

References	
1	Stocker. ,"Refrigeration and Air Conditioning", McGraw-Hill Publishing , 2nd Edition,2008
2	W. P. Jones, "Air Conditioning Engineering", Rutledge, 5th Revised Edition, 2001.
3	Willis H. Carrier, "Carrier Hand Book "Jonathan Castro, 2013

Useful Links	
1	https://www.youtube.com/watch?v=4HmA3sT0C1Y&t=11s
2	https://www.youtube.com/watch?v=5dgRgBuWDZw&t=2s
3	https://www.youtube.com/watch?v=MjZahESS-48
4	https://www.youtube.com/watch?v=14-kyt-a1DU

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2							2		1				
CO2	2	2			1									
CO3	2									1	1			

The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO, and preferably to only one PO.

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%

Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External	During Week 18 to Week 19 Marks Submission at the end of Week 19	40

		Examiner as applicable		
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

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(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME441
Course Name	Mini Project 5
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	2 Hrs./Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 01			

Course Objectives

1	To acquaint with the process of identifying the needs and converting it into the problem.
2	To familiarize the process of solving the problem in a group.
3	To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4	To inculcate the process of self-learning and research.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Apply Knowledge and skill to solve academic / industrial / societal problems in a group.	III	Applying
CO2	Develop interpersonal skills to work as member of a group or leader.	III	Applying
CO3	Draw the proper inferences from available results through theoretical / experimental / simulation work.	V	Evaluating

Course contents

Guidelines for Mini Project 5:

1. Students are required to work in a group of maximum five students, and this group shall be the same as the project batch for the final year project.
2. Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor.
3. Students need to choose different topic for mini project than their final year B. Tech project.
4. Students shall submit implementation plan in the form of Gantt / PERT / CPM chart, which will cover weekly activity of mini project.
5. A log book is to be prepared by each group, wherein group can record weekly work progress,
6. Faculty advisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
7. Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

8. Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
9. The solution to be validated with proper justification and report to be compiled in standard format as defined by the department.
10. The project work can be any of the form given below **but not limited to** :
    a. Making physical working models, prototypes, and scaled models, of a concept machine.
    b. Making virtual / CAD models of a sufficiently complex machines / concepts.
    c. Making study, modeling, analysis, programming and simulation of a system / machine / operation / process.
    d. Making study / teaching modules of a sufficiently complex topic for pedagogy purposes.
    e. Any other project work in mechanical or multidisciplinary area in consultation with the faculty in charge.
11. Students can use workshop facility, different laboratory facilities, software, mathematical tools, simulation / animation tools etc. available or online freeware tools.
12. With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that the mini project of appropriate level and quality to be carried out.
13. Students need to ensure that mini project is not repeated from previous three years.
14. Students may complete mini project as an industry sponsored project, in consultation with the faculty advisor.
15. The students group can be allowed to work on the extension of the Mini Project 3 /4 with suitable improvements / modifications or a completely new project idea. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project Practical / Oral Examination:

- Report should be prepared as per the guidelines issued by the department.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to faculty advisor.
- Students shall be motivated to publish a paper based on the work in student competitions / Conferences / journals.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Fluency in written and oral communication
9. Quality of project report

Text Books	
1	Suitable books and e books on design engineering, manufacturing processes, thermal engineering, design of experiments, optimization techniques suitable for selected project domain.
References	
1	Suitable user manuals of software tools and research papers from reputed national and international journals and conferences.
Useful Links	
1	Any online resources suitable for project domain.

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3								3			3	2	
CO2	2	3	3						3			2	2	1
CO3				3		2		3	2	2	3	3		1
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information	
Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME453
Course Name	Techno Socio Activity
Desired Requisites:	

Teaching Scheme		Examination Scheme (Marks)			
Practical	-	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	1 Hrs./Week	15	15	20	50
		Credits: 1			

Course Objectives

1	In this course the student performance in co-curricular and extra-curricular activities over four years will be considered.
2	The institute, state, national and international level activities are like technical events, Sports, Cultural, Social, and Students Club etc. These activities help the students to develop leadership skills, team integrity, coordination skills, Time management, Communications skills, Interviewing skills etc. These activities help the students to know his or her intelligence. The evaluation will be done by the mentor who is mentoring the student during graduation period.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Notice an improvement in his/her understanding and presentation skills.	III	Applying
CO2	Understand and value the importance of working in a diversified team/areas.	IV	Analyzing
CO3	Demonstrate the soft skills like presentation skills, technical report writing etc.	V	Evaluating

List of Experiments / Lab Activities

The proctor faculty will be mentoring a given student batch for the duration of four years. The students shall submit proof of their achievements in various extra and co-curricular activities from First year to Final year. The faculty will evaluate the students' performance at the end of 8th semester, based on the Rubrics provided by the department from time to time.

Text Books

1	Not applicable.

References

1	Not applicable.

Useful Links

1	Not applicable.

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								1					1	1
CO2									2					2
CO3							1						2	
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME454
Course Name	Project I
Desired Requisites:	Basic and advanced concepts and principles in mechanical engineering, graduate level courses. Latest developments in mechanical engineering field.

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	6 Hrs/Week	**LA1**	**LA2**	**ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 03			

Course Objectives

1	Provide an opportunity to students to do work independently on a topic/ problem experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances and limitations.
2	Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.
3	To enable students to for technical report writing and effective presentations.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Will be able to understand the importance of team work and will be able to work in a team for achieving group goals / will be prepared to assume a leadership role in any team.	III	Apply
CO2	Will have ability to explain various concepts and tools used in their project. Will be able to analyze and give solutions for a specific problem statement related to their project.	IV	Analyze
CO3	Will be able to prepare and present a detailed report based on project work spread over two semesters.	V	Evaluate

Course contents

Project Definition:-

- Creation of product, apparatus, small equipment, test setup, experimental set up, prototype based on new idea.
- Innovation of existing product.
- Energy audit/ conservation-studies of department/ section / plant /organization / machine etc.
- Making of machine and renovation of machine.

- Experimental set up to verify and confirm scientific concepts.
- Experimental verification of principles of mechanical engineering, analysis or simulation of a process.
- Multidisciplinary projects.
- Projects using modern electronic / computer based tools, software etc. in consultation with faculty in-charge.

Industry sponsored projects:
Students may carry out sponsored project fulfilling the requirements mentioned above.

The project contents should be such that it is to be carried out over entire academic year by the group.

Synopsis:-
Synopsis should contain:-
a. Need of project- How you are inspired of particular project.
b. Aim and objective of project topic.
c. Idea/ideas used in the project work.
d. How will you execute the proposed idea
e. Various steps that will be followed (sequential) in the project work.
f. Schedule to be followed for completion of project work.
g. Cost estimate for the project including material / financial assistance expected from the department.
h. Classification of the project such as In-house, Sponsored, Lab development, software based etc.

Work diary:
Each project group shall maintain the record about project work details containing following points:
• Searching suitable project work
• Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring out the project.
• Brief report of feasibility studies carried to implement the conclusion.
• Rough Sketches/ Design Calculations, etc.

Students are encouraged to publish a technical paper in conference / reputed peer reviewed journals based on their project work.

Project shall be assessed based on following points;
1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Fluency in written and oral communication
9. Quality of project report

Text Books	
1	Suitable books based on the contents of the project selected.
References	
1	Suitable books based on the contents of the project selected and research papers from reputed national and international journals and conferences.
Useful Links	

1	As per the need of the project.

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3								3			3	3	
CO2		3	3	3	3		2		3		3		2	1
CO3		3						3		3	3			1
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule (for 26-week Sem)**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME455
Course Name	H-3 Project Management
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	1 Hour/week	15	15	20	50
		Credits: 1			

Course Objectives

1	To prepare the students to manage projects by exploring both technical and managerial challenges and preparing the budget.
2	To make aware the students about leadership and ethical qualities in dealing with real life project
3	To induce qualities for working in interdisciplinary and cross functional teams with effective communication skills, economical and managerial challenges and commercial management.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Grasp and perceive the project activities with respect to resources required and the constraint for feasibility or completion within time	II	Understanding
CO2	Estimate and prepare budget for project completion, Understand commercial management	IV	Analyzing
CO3	Figure out and schedule the project and assess for controlling critical path networks	V	Evaluating

Contents

Module	Module content	Hours
1	Introduction to Project Management.	2
2	Project Cost, Planning, feasibility, risk.	2
3	Critical Path Networks - Principles of Resource Scheduling.	2
4	Executing and Controlling.	2

5	Commercial Management and various regulations.	2
6.	Study and use of software related to Project Management System.	3

Text Books	
1	Dennis Lock , Project Management - Gower Publishing Limited, 2013
2	Samuel J. Mantel, Jr., Jack R. Meredith, Scott M. Shafer, Margaret M. Sutton, Project Management in Practice - JOHN WILEY & SONS, INC., 2011
3	B.C. Punmia and Khandelwal, Project Planning and Control with PERT and CPM, Lakshmi Publications Pvt. Ltd., 2001
4	HoraldKerzner, Project Management: A systems approach to planning, scheduling and controlling, John Wiley & Sons Inc., 2009
5	The factories act 1948 – Government of India 6. Meri Williams , The Principles of Project Management By – SitepointPvt Ltd., 2008

References	
1	K. Nagarajan, Project Management, New Age Int., 2nd ed. 2004.
2	B.M.Naik, Project Management-Scheduling and Monitoring by PERT/CPM, 1984
3	William R Duncan, A guide to the project management body of knowledge, PMI Publications, 1996

Useful Links	
1	https://www.apm.org.uk/resources/what-is-project-management/
2	https://www.projectmanager.com/project-management

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								1					1	1
CO2									2					2
CO3							1						2	

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME411
Course Name	Finite Element Method
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To explain the general steps in finite element method.
2	To solve various field problems using finite element method.
3	To apply variational formulation method to solve mechanical engineering problems.
4	To use modern software to simulate structural, thermal and fluid problems.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the use of mathematical modeling and FEM.	III	Applying
CO2	Use modern tools, software, and equipments to analyze and solve the problems and interpret the data	IV	Analyzing
CO3	Analyze mechanical components, systems and projects required for industry by using FEM.	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction to FEM** Basic concepts of FEM – Historical background, relevance and scope for FEM – need for approximation, applications of FEM in various fields, advantages and limitations of FEM.	6
II	Introduction Discretization, interpolation, shape function, formulation of element characteristics matrices, assembly and solution.	7
III	Introduction, Geometrical approximations, Simplification through symmetry, Basic element shapes and behaviour, Choice of element type, Size and number of elements, Element shape and distortion, Location of nodes, Node and element numbering.	7
IV	Types of elements, order of element. Formulation of element characteristic matrices and vectors for elasticity problems: One dimensional elasticity – two dimensional elasticity, axi-symmetric elasticity. Formulation procedures, the variational formulation, the weighted residual method. Thermal problems, one dimensional heat transfer, two dimensional heat	7

	transfer, Torsional problems, Fluid flow problems.	
V	Introduction, co- ordinate transformations, assembly of element equations, incorporation of the boundary conditions, solution of the equations, matrix operations, elimination method, penalty method	6
VI	Model validity and accuracy, mesh design and refinement, element distortions, result processing, model checking.	7

Text Books	
1	S. S. Rao, "Finite Element Method in Engineering", Elsevier Publication, 4th Edition, 2004
2	P. Seshu, "Textbook of Finite Element Analysis",1st Edition. 2008.
	M. J Fagan, "Finite Element Analysis- Theory and Practice"; Longman Scientific & Technical, 1st Edition, 1992
References	
1	J. N. Reddy, "An Introduction to Finite Element Method", Tata McGraw Hill publication co. 2nd Edition, 1993
2	Logan D. L. "A first course in Finite Element Method", Cengage learning, 4th Edition, 2008.
3	O. C, Zienkiewicz "The Finite Element Method – Basic Concepts and Linear Applications", Tata McGraw Hill publication co., 5th Edition, 2000
Useful Links	
1	https://nptel.ac.in/courses/112/106/112106135/
2	https://nptel.ac.in/courses/112/104/112104115/

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2											3	3	
CO2			1	2				2					2	2
CO3		2						2				2		1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information	
Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME412
Course Name	Industrial Engineering
Desired Requisites:	

Teaching Scheme		Examination Scheme (Marks)			
Lecture	3Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
	-	**Credits: 03**			

Course Objectives

1	To make the students to aware about processes, methods for effective planning, controlling, and implementing projects.
2	To utilize the tools and techniques for solving industrial engineering problems.
3	To apply project management related tools in the industry.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	Course Outcome Statement/s	Bloom's Taxonomy Level	Bloom's Taxonomy Description
CO1	Explain methods, processes, and their types in industrial engineering.	III	Applying
CO2	Illustrate the basic concepts of industrial engineering in the manufacturing and service sector.	IV	Analyzing
CO3	Examine various tools and techniques for solving the industrial engineering problems.	V	Evaluating

Module	Module Contents	Hours
I	**Introduction of I.E., Productivity and PPC** Definitions, functions and status of I.E. department in Manufacturing organization and Service sector, Productivity – concept and objectives, factors affecting, tools and techniques, Value analysis. Production Planning and Control – Elements and functions of PPC, Sales forecasting and methods of Capacity requirement planning.	6
II	**Plant Layout and material handling** Plant layout:-Site selection, principles and objectives, production types, tools and techniques used, maintenance, line balancing, layout planning. Material handling: - Objective, elements, functions, principles, types of material handling equipments, unit load concept, Economics of material handling.	7
III	**Method study** Definitions, objectives, various recording techniques, methods improvement techniques, principles of motion economy, Therbligs, micro-motion study, MOST	6
IV	**Work measurement**	7

	Definitions, objectives, activity and elements, performance rating, rating methods, allowances, group timing techniques, work sampling, PMTS.	
V	**Inventory Control** Different Models of Inventory Systems, MRP, Make or Buy decision.	7
VI	**Network Techniques** CPM and PERT, Construction, Time cost trade off.	6

Text Books	
1	Khanna O.P., "Industrial Engineering and Management", Dhanpat Rai Publications (P) Ltd, New Delhi. Year 2003
2	Martand Telsang "Industrial Engineering and Production Management" S. Chand & Company Ltd., New Delhi Year 2003

References	
1	Gavrial Salvendy" Handbook of Industrial engineering" John Wiley and sons, New York, 2007
2	M. I. Khan "Industrial Engineering" New age international(P) Ltd, New Delhi, 2004
3	International labour office, "Introduction to work study" Publisher International Labour office,1969, Digitalized edition, 2008

Useful Links	
1	https://nptel.ac.in/courses/112/107/112107142/
2	https://www.myklassroom.com/Engineering-branches/28/Industrial-Engineering
3	https://www.youtube.com/watch?v=yhywrCChJBQ&feature=emb_imp_woyt

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1					**2**				**3**				3	
CO2				**3**	**1**	**2**							2	2
CO3					**2**		**2**	**3**						3

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment (for Theory Course)

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	5ME413
Course Name	Solid Mechanics
Desired Prerequisites:	Advanced Strength of Materials

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide students a sound knowledge in stress analysis required to solve the problems in industry
2	To teach the mathematical and physical principles in understanding the linear continuum behavior of solids.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Discuss the different concepts in stress analysis.	II	Understanding
CO2	Apply basic relations between stress and strains to solve complex problems in stress analysis.	III	Applying
CO3	Analyse the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.	IV	Analyzing

Module	**Module Contents**	**Hours**
I	**Analysis of Stress and Strain** Introduction, Concepts in Stress and Strain analysis, Principal stresses, Governing equations in cartension and polar coordinates, Generalized Hooke's law	7
II	**Two Dimensional Problems in Elasticity** Plane stress and plane strain problems. Stress function, stress function for plane stress and plane strain cases. Solution of two-dimensional problems with different loading conditions by the use of polynomials.	6
III	**Axisymmetric Loaded Members**	6

	Governing equations, stress in thick walled cylinder under internal and external pressure, stresses in rotating flat solid disk, flat disk with central hole	
IV	**Torsion** Torsion of prismatic bars of solid section, Membrane analogy, Torsion of thin walled of open cross section and multiple cell closed sections.	7
V	**Thermal Stresses** Thermoelastic stress-strain relations, Equations of equilibrium, Strain-displacement relations, Thin Circular disk: Temperature symmetric about centre, Long Circular cylinder	7
VI	**Plasticity** Theoretical concepts of plasticity, The flow curve, True stress and True strain, Yield criteria, Plastic stress strain relationship, Elastic plastic problems in bending. Some engineering applications of elasticity and plasticity	6

Text Books	
1	S.P. Timoshenko and J.N. Goodier, *"Theory of Elasticity"*, McGraw-Hill Publishing Co. Ltd., 3rd Edition, 1970.
2	Beer and Johnston, *"Mechanics of Materials"*, McGraw Hill, 6th Edition , 2012
3	L.S. Srinath, "*Advanced Mechanics of Solids*", Tata McGraw-Hill Publishing Co. Ltd, 3rd Edition 2009.

References	
1	Shames, I.H. and Pitarresi, J.M, *"Introduction to solid Mechanics"*, PHI learning Pvt. Ltd, 3rd Edition, 2009
2	Hulse, R and Cain J, *"Solid Mechanics"*, Palgrave publisher, 2nd Edition, 2004.
3	F.B Seely and Smith, *"Advanced Mechanics of Materials"*, John Wiley & Sons, 2nd Edition, 1978.

Useful Links	
1	https://nptel.ac.in/courses/112/101/112101095/
2	https://nptel.ac.in/courses/105/105/105105177/
3	https://nptel.ac.in/courses/112/107/112107146/

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**2**												**2**	
CO2			**2**								**3**	**3**	**2**	
CO3	**2**		**2**									**3**	**2**	

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5ME421
Course Name	Automobile Engineering
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To make students familiar with various basic systems of a modern automobile.
2	To introduce the mathematical treatments required for vehicle performance and for some of important systems such as steering system and brake system.
3	To make students aware about latest trends in transportation towards a safe, pollution free and fully automatic vehicle.
4	To empower students to face the real life automotive usage with greater confidence.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Comprehend about various automotive systems and recent trends in automobile design, development, manufacturing and assembly.	II	Understanding
CO2	Relate concepts of vehicle dynamics with daily experiences.	III	Applying
CO3	Analyze acceleration, barking and steering performance of a vehicle in different driving conditions.	IV	Analyzing

Module	**Module Contents**	**Hours**
I	**Introduction, classification and Automotive power plants** Introduction, Broad classification of Automobiles. Major components and their functions. Types of vehicle layouts, Types of bodies. Requirements of automotive power plants, Comparison and suitability considerations. Electric and Hybrid vehicles- Layout, advantages and limitations.	4
II	**Vehicle Performance** Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Gradeability and draw bar pull, Traction and Tractive effort, Distribution of weight, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio.	7
III	**Automobile Systems** Transmission System : Function, requirement and types of following parts:	9

	Automobile clutch, Gearbox, Differential, final drive, rear axle, propeller shaft. Suspension, Steering Braking and Electrical System: Function, types, requirements of the above mentioned systems. Key concepts of each of the mentioned systems. (Numericals from suspension, steering and braking systems only. Theory part of electrical system)	
IV	**Introduction to Hybrid and Electric Vehicles** Electric Vehicles: Architecture of an electric vehicle, essentials and performance of electric vehicles Traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations. Hybrid Vehicles: Hybrid electric drivetrains concepts, architecture, design, control strategies, merits and demerits.	6
V	**Electric Propulsion Systems & Energy storage devices** Electric propulsion systems: DC motor drives, induction motor drives, permanent magnet motor drives and switched reluctance motor drives. Energy Storage Devices: Electrochemical batteries, thermodynamic voltage, lead-acid batteries, nickel based batteries, lithium based batteries, flywheel and ultra-capacitors, Battery management systems, range calculation.	7
VI	**Vehicle Testing and Recent trends in Automotive Development** Road Test, free acceleration test, down test, passer by noise test, road load data acquisition for vehicle. Test tracks: Proving ground testing, high speed track, pavement track, corrugated track, mud track, steering pad, gradient and other related tests. NVH and crashworthiness of vehicles, Emission norms and control. Recent advances in automobiles.	6

Text Books	
1	Kripal Singh, “Automobile Engineering Vol. II”, Standard Publishers Distributors, Tenth Edition , 2007
2	P S Gill, “Automobile Engineering II”, S K Kataria and Sons, Second Edition, 2012
3	R K Rajput, “Automobile Engineering”, Laxmi Publications, First Edition, 2007
4	Iqbal Husain, “Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011
5	Mehrdad Ehsani, YiminGao, Sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2009.

References	
1	Newton, Steeds and Garrett, “The Motor Vehicle”, Butterworths International Edition, 11th Edition, 1989
2	Crouse and Anglin, “Automotive Mechanics”, McGrawhill Publication, Tenth Edition, 2007
3	P W Kett, “ Motor Vehicle Science Part - 2, “ Chapman & Hall” , 2nd Edition, 1982
4	James Larminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003.
5	Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes, 2000

Useful Links	
1	https://nptel.ac.in/courses/107/106/107106088/
2	https://nptel.ac.in/courses/107/106/107106080/
3	https://ed.iitm.ac.in/~shankarram/Course_Files/ED5160/ED5160_Journal_Complete_Notes.pdf
4	http://nptel.ac.in/courses/108103009/

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			**2**							**1**			2		
CO2								**3**			**2**			2	
CO3		**1**		**2**								**2**		3	
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.															

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5ME491
Course Name	Project 2
Desired Requisites:	Basic and advanced concepts and principles in mechanical engineering, graduate level courses. Latest developments in manufacturing technology.

Teaching Scheme		**Examination Scheme (Marks)**			
Practical	12 Hrs./Week	**LA1**	**LA2**	**Lab ESE**	**Total**
Interaction	-	30	30	40	100
		Credits: 6			

Course Objectives

1	To help students to identify real life needs and discuss project requirements.
2	To give technical solutions through the latest design & development tools.
3	To direct students to compare and analyze the IT platforms for efficient solutions.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Integrate project at each stage of the software development life cycle.	III	Applying
CO2	Recommend project plans that address real-world challenges. Develop successful software projects that support program's strategic goals and satisfies the customer needs.	IV	Analyzing
CO3	Integrate project at each stage of the software development life cycle.	V	Evaluating

List of Experiments / Lab Activities/Topics

- Completion of manufacturing / processing-assembly / testing / analysis / simulation work of the project.
- Testing, result analysis etc.
- Demonstration of the working of the project
- Rectifications/ correction if required to be completed.

Students are encouraged to publish a technical paper in conference / reputed peer reviewed journals based on their mini project work.

Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements

5. Effective use of skill sets 6. Effective use of standard engineering norms 7. Contribution of an individual's as member or leader 8. Fluency in written and oral communication 9. Quality of project report

Text Books	
1	Suitable books based on the contents of the project selected.
References	
1	Suitable books based on the contents of the project selected and research papers from reputed national and international journals and conferences.
Useful Links	
1	As per the need of the project.

CO-PO Mapping														
	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3								3			3	3	
CO2		3	3	3	3		2		3		3		2	1
CO3		3						3		3	3			1
The strength of mapping is to be written as 1,2,3; where, 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO, and preferably to only one PO.														

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing.(min 40 %), LA1+LA2 should be min 40%				
Assessment	**Based on**	**Conducted by**	**Typical Schedule**	**Marks**
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 8 Marks Submission at the end of Week 8	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 9 to Week 16 Marks Submission at the end of Week 16	30
Lab ESE	Lab activities, journal/ performance	Lab Course Faculty and External Examiner as applicable	During Week 18 to Week 19 Marks Submission at the end of Week 19	40
Week 1 indicates starting week of a semester. Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming, and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments and related activities if any.				

Walchand College of Engineering, Sangli
(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5ME431
Course Name	Computational Fluid Dynamics
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To familiarize the students about different prediction methods and the role of CFD.
2	To prepare the students to derive different forms of governing equations used in CFD and their significance.
3	To analyze N-S equations and the different numerical techniques used in CFD.
4	To train the students to select the appropriate conditions to solve the problem with CFD.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Summarize the prediction methods and basic methodology of CFD.	II	Understanding
CO2	Derive various governing equations in different forms.	III	Applying
CO3	Analyze the different numerical techniques for solving fluid flow problems.	IV	Analyzing

Module	**Module Contents**	**Hours**
I	**Introduction** Prediction method, experimental techniques, analytical methods, CFD application, typical problems/ Problem Solving with CFD – Methodology.	7
II	**Conservation laws and the model equations** Governing equations of fluid flow and heat transfer, Equations of the state, Navier-Stokes equations for a Newtonian fluid, Conservative form of the governing equations of fluid flow, Differential and integral forms of the general transport equations, Classification of physical behavior.	6
III	**Exact solution of the Navier-Stokes equations and boundary conditions** Introduction, Transformation of the Governing Partial Differential Equations, Grid Generation Techniques. Boundary conditions: introduction, types of boundary conditions, Potential pitfalls and final remarks.	7
IV	**Basic computational techniques:** Finite Difference Formulations: Introductory remarks, Taylor Series Expansions, Finite difference by Polynomials, Finite difference equations, Applications. Finite	6

	Volume Method: Introduction, Steady one-dimensional problem, the central discretization schemes, Properties of discretization schemes, Assessment of the central differencing scheme for convection-diffusion problems, 1-D examples, 2-D examples.	
V	**Solution methods** This chapter deals with basic numerical discretization approaches discussed in earlier chapter and mold them into various techniques that will allow the numerical solution of flow problems. Lax- Wendroff Technique McCormack's Technique, Crank-Nicolson Technique ,Relaxation Technique, ADI Technique, Pressure correction Technique.	7
VI	**Post processing** Results are usually reviewed in one of two ways. Graphically and Alpha numerically. Graphically: Vector plots, Contours, Iso-surfaces, Flow lines, Animation. Alpha numerical techniques.	6

Text Books	
1	Anderson, J.D., "Introduction to Computational fluid Dynamics", McGraw Hill Publication 2008
2	Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, 2nd edition, New Delhi 2011.
3	Hoffmann K. A "Computational Fluid Dynamics" Publication of engineering education system, 2000.

References	
1	Suhas V. Patankar, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
2	H. K. Versteeg and W Malalasekera, "Introduction to Computational Fluid Dynamics" Longman group, 1998.
3	Fletcher C.A.J., "Computational Techniques for Fluid Dynamics I," Fundamental and General Techniques, Springer-Verlag, 1987

Useful Links	
1	https://nptel.ac.in/courses/112/107/112107208/
2	https://nptel.ac.in/courses/103/106/103106073/

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2												3	
CO2			2									3	2	2
CO3		2												1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment (for Theory Course)

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.

For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information	
Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5ME432
Course Name	Total Quality Management
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives	
1	To make the students to understand fundamental principles of total quality management.
2	To provide the students the knowledge of new concepts like customer focus, customer retention and associated costs.
3	To prepare the students for the analysis and use of various TQM tools.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Understand on quality management philosophies and frameworks.	II	Understanding
CO2	Develop in-depth knowledge on various tools and techniques of quality management and their application.	III	Applying
CO3	Learn the applications of quality tools and techniques in both manufacturing and service industry.	IV	Analysing

Module	**Module Contents**	**Hours**
I	**Introduction** Definitions of quality, need and evolution of quality, product quality and service quality, costs and value of quality, basic concepts of TQM, TQM framework, quality gurus and contributions, barriers to TQM, customer focus, customer satisfaction, customer complaints and customer retention	7
II	**TQM Principles** Leadership, strategic quality planning, employee involvement and empowerment, teamwork, quality circles, recognition and reward, performance appraisal, continuous process improvement, supplier partnership, supplier rating and selection	6
III	**TQM Tools** Control charts, process capability, six sigma- concepts, methodology, applications, bench marking process, FMEA- stages and types, PDCE cycle, 5S, Kaizen	7

IV	**TQM Techniques** Just in time (JIT), Quality Function Deployment (QFD), Taguchi quality loss function, TPM- concepts, improvement needs, performance measures	7
V	**Quality systems** Need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation,; Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits	6
VI	**TQM Implementation** TQM implementation in manufacturing and service sectors, case studies of TQM implementation	6

Text Books	
1	Besterfield D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006
2	Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th edition, Cengage Learning, 2012
3	Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006

References	
1	Juran J.M. & Gryna , Quality Planning and Analysis
2	Feigenban, Total Quality Control, McGraw Hill Book Company
3	Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006

Useful Links	
1	https://nptel.ac.in/courses/110/104/110104080/
2	https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-me26/

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1												2	
CO2	2		2					2			1			
CO3	1	3						1						

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5ME433
Course Name	Condition Monitoring of Machines and Signal Processing
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To make students aware of some methods and procedures applied for general Condition Monitoring.
2	To make students appreciate and understand the basic idea behind vibration-based structural health monitoring and vibration-based condition monitoring, know the general stages of CM
3	To prepare students capable to apply some basic techniques for analysis of random and periodic signals
4	To prepare students aware of some basic instrumentation used for machinery and structural vibration-based monitoring

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Calculate the characteristic of problems related to vibrations	V	Evaluating
CO2	Apply knowledge for preventive maintenance	III	Applying
CO3	Investigate the data for troubleshooting vibration problems in the mechanical machines	IV	Analysing

Module	**Module Contents**	**Hours**
I	**Types of Maintenance** Types of maintenance, basic idea of health monitoring and condition monitoring of structures and machines. Critical speed of shafts, Some basic techniques.	7
II	**Signal Processing** Study of periodic and random signals, probability distribution, statistical properties, power spectral density functions of commonly found systems, spectral analysis	6
III	**Fourier Transform** Fourier transform: the basic idea of Fourier transform, interpretation and application to real signals, resonant frequencies, modes of vibration	6
IV	**Vibration Based Fault Diagnosis** Introduction to vibration-based monitoring, Machinery condition monitoring by vibration analysis: Use and selection of measurements, analysis procedures and instruments	6
V	**Applications of Condition Monitoring** Typical applications of condition monitoring using vibration analysis to rotating machines, unbalance, misalignment, faulty gears and bearings, vibration problem related to the foundation. Transmissions of vibration and its isolation	7
VI	**Other Health Monitoring Techniques** Other health monitoring techniques, acoustic emission, oil debris and temperature analysis, Applications	6

Text Books

1	Adams M. L., Rotating Machinery Analysis - from Analysis to Troubleshooting, CRC Press, 2nd edition, 2009
2	Cornelius S., Paresh G., Practical Machinery Vibration Analysis and Predictive Maintenance, Newnes, 1st edition, 2004
3	Mohanty A. R., Machinery Condition Monitoring-Principles and Practices, CRC Press, 1st edition, 2015
References	
1	William J. H., Davis N., Drake P. R., Condition Based Maintenance and Machine Diagnostics, Springer Netherlands , 2nd edition, 1994
2	L.L. Faulkner, Handbook of Industrial Noise Control, Industrial press, 1st edition 1976
3	Rao S. S., Mechanical Vibrations, Pearson education, 5th edition, 2010
Useful Links	
1	https://www.youtube.com/watch?v=aKcDBg8c4hk
2	https://www.youtube.com/watch?v=6dFnpz_AEyA
3	https://nptel.ac.in/courses/112/105/112105232/
4	https://nptel.ac.in/courses/112/105/112105048/

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1				**2**					**1**				1	
CO2							**2**				**2**			3
CO3	**2**		**3**									**2**		3

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., SEM-VIII
Course Code	5ME434
Course Name	Gas Dynamics and Jet Propulsion
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To introduce students about the basic difference between incompressible and compressible flow
2	To provide knowledge related to phenomenon of shock waves and its effect on flow.
3	To prepare the students To gain some basic knowledge about jet propulsion and Rocket Propulsion.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Interpret the basic difference between incompressible and compressible flow.	II	Understanding
CO2	Recognize phenomenon of shock waves and its effect on flow.	III	Applying
CO3	analyze gas dynamics principles in the Jet and Space Propulsion	IV	Analyzing

Module	**Module Contents**	**Hours**
I	**Basic Concepts And Isentropic Flows** Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers.	7
II	**Flow Through Ducts** Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties.	7
III	**Normal And Oblique Shocks** Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications	6
IV	**Jet Propulsion** Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines.	7
V	**Space Propulsion Gas Dynamics And Jet Propulsion** Types of rocket engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion.	6

VI	**Performance Study** Performance study – Staging – Terminal and characteristic velocity – Applications – space flights.	6

Text Books	
1	Anderson, J.D., "*Modern Compressible flow*", 3rd Edition, McGraw Hill, 2003.
2	Yahya, S.M. "*Fundamentals of Compressible Flow*", New Age International (P) Limited, New Delhi, 1996.

References	
1	Cohen. H., G.E.C. Rogers and Saravanamutto, "Gas Turbine Theory", Longman Group Ltd.,1980
2	Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, 2010.
3	Shapiro. A.H.," Dynamics and Thermodynamics of Compressible fluid Flow", John wiley, New York, 1953.

Useful Links	
1	https://nptel.ac.in/courses/112/106/112106166/
2	https://web.iitd.ac.in/~pmvs/course_mcl341.php
3	https://arc.aiaa.org/loi/jjp

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2												3	
CO2			2									3	2	2
CO3		2												1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5ME435
Course Name	Computer Integrated Manufacturing
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To expose the student to the various fundamentals of computer assisted manufacturing systems.
2	To make the students familiar with criteria for implementing systems associated with software and CAD/CAM database for design and manufacturing.
3	To explain students about Robotics and its allied interdisciplinary approach, component design, sensor technology, computer science and artificial intelligence.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Choose sensors, actuators and motion conversion devices in logical way.	III	Applying
CO2	Defend the working of Robot software/ hardware in CIM environment	V	Evaluating
CO3	Design of the modern information processing system through computers.	VI	Creating

Module	**Module Contents**	**Hours**
I	**Computer Integrated Manufacturing** - Introduction, definition, importance, components, automation and evolution of CIM. Advantages, limitations, scope and globalization view. - Product Development through CIM: Introduction, product development cycle, sequential engineering, concurrent engineering, comparison between SE and CE, implementation of CE, CE and IT, soft and hard prototyping, characteristics of CE, success of CE, applications of CE.	6
II	**Automated Quality Control and CIM Implementation** - In-process and post process methodologies, integrations of CNC machines, robot in CIM environment.	7

	- Communication, software/ Hardware: Availability of software, network topologies for LAN, network interface card and protocols, Network operating systems. - CIM models: Introduction, ESPRIT- CIM OSA model, the NIST- AMRF hierarchical model, the Siemens model, digital equipment corporation model, IBM concept of CIM.	
III	**Computer Aided Process Planning** Structure, information requirements, CAD based process planning, Group Technology, Coding structure, MICLASS system, Variant and generative process planning, Implementation considerations	6
IV	**Robotics in CIM** Historical development, various terminologies, classification, degrees of freedom and degrees of motion, manipulation of robot components, joints and symbols, work volume, work envelope, accuracy and repeatability, configuration, Numerical examples.	7
V	**Robot Programming and Modular Components** Methods, languages, advantages and limitations of robot, requirements for robot in an Industries, specifications of robot, operational capabilities level of robot, modular robot components, wrist mechanism, Numerical examples. Robot Sensors, Actuators and Motion Conversion: -Internal and external sensors, force sensors, thermocouples, performance characteristics, standard test signals, controllers, PLC and robotics. -Robot actuators, micro grippers, motion conversion systems, harmonic drives, robot safety.	8
VI	**Advanced Systems** Heuristics decision for robot, Fuzzy logic for robot control, Artificial Neural Network for robotics, Biped Robot, Biomimetic robotics, calibration. Shop floor data collection, Automatic data collection, Data acquisition system	5

Text Books	
1	Groover M.P, "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall International publication, 2004.
2	AppuKuttan K.K, "Robotics", I. K. International publication, 2007.
3	Groover M.P., Nagel R.N., Ordey N.G. "Industrial Robotics- Technology, Programming and Applications," McGraw Hill International, 2012.

References	
1	Richard M. Murrai, Zexiang Li, S Shankar Sastry, "Robotic Manipulation," CRC Press, 2001
2	S.R. Deb, "Robotics Technology and Flexible Automation," Tata McGraw Hill, 2000
3	Urich Rembold, "Computer Integrated Manufacturing Technology and System," 1995

Useful Links	
1	https://nptel.ac.in/content/storage2/112/105/112105249/MP4/mod01lec01.mp4
2	NPTEL Link: https://youtu.be/a6_fgnuuYfE
3	NPTEL Link: https://youtu.be/49RET0N-ITY
4	NPTEL Link: https://youtu.be/9fqygvj-O2s

CO-PO Mapping														
	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1			1			2							2	2
CO2						1						2		3
CO3											2			
The strength of mapping is to be written as 1: Low, 2: Medium, 3: High Each CO of the course must map to at least one PO.														

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5ME436
Course Name	Design of Transmission System
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To train students in the standard procedure available for design of transmission systems of machines.
2	To provide the students with knowledge of gear design.
3	To prepare the students to succeed as designer in industry/technical profession.
4	To provide students with a sound foundation in the use standard data and catalogues

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Describe the theory of power transmission and gear box design.	II	Understanding
CO2	Utilize the given data tables to arrive at proper specifications of flexible power transmission element.	III	Applying
CO3	Design the gear box as per the need of functioning of machine.	VI	Creating

Module	**Module Contents**	**Hours**
I	**Belt and Pulleys** Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets	6
II	**Spur Gears** Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears.	8
III	**Bevel and Worm Gears** Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears; Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears.	7
IV	**Design of Gear Box**	8

	Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box, Design of multi-seed gear box for machine tool applications; constant mesh gear box	
V	**Cam Design** Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses	5
VI	**Clutch and Brake Design** Design of plate clutches, axial clutches, cone clutches, internal expanding rim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes, internal expanding shoe brake.	6

Text Books	
1	Bhandari V.B., Design of Machine Elements, 3rd edition, Tata McGraw-Hill Book Co, 2018
2	Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th edition, Tata McGraw Hill, 20104.
3	Mehta N.K., Machine Tool Design and Numerical Control, 3rd edition, Tata McGraw Hill, 2012

References	
1	Norton R.L., Design of Machinery, McGraw Hill Publication, 3rd edition, 2013
2	Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
3	Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd edition, Tata McGraw Hill, 2001
4	PSG Design Data Book

Useful Links	
1	https://nptel.ac.in/courses/112/106/112106137/
2	https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-me16/
3	https://www.digimat.in/nptel/courses/video/112105234/L35.html

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1			**2**							**1**			2	
CO2								**3**			**2**			2
CO3		**1**		**2**								**2**		3

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., SEM-VIII
Course Code	5ME437
Course Name	Combustion
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To learn about applications and scope of combustion.
2	To understand thermodynamics , chemistry and physics of combustion
3	To learn laminar premixed flame and flame stabilizations.
4	To learn about the compressors with and without intercooling.
5	To learn the spray and solid fuel combustion.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Understand applications and scope of combustion.	II	Understanding
CO2	Understand chemistry and physics of combustion.	II	Understanding
CO3	Analyze premixed flame and diffusion characteristics.	III	Analyzing

Module	**Module Contents**	**Hours**
I	**Introduction:** Introduction to combustion, Applications of combustion, Types of fuel and oxidizers, Characterization of fuel, Various combustion mode, Scope of combustion.	6
II	**Thermodynamics of Combustion:** Thermodynamics properties, Laws of thermodynamics, Stoichiometry, Thermochemistry, adiabatic temperature, chemical equilibrium.	7
III	**Chemistry of Combustion:** Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.	6
IV	**Physics of Combustion:** Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow.	7
V	**Premixed Flame:** One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame.	6
VI	**Diffusion Flame:** Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion**.**	7

Text Books	
1	D.P. Mishra, Fundamentals of Combustion, Prentice Hall of India, New Delhi, 2008.
References	
1	Kuo K.K. “Principles of Combustion” John Wiley and Sons, 2005.
2	Strehlow R A., “Fundamentals of combustion” McGraw Hill Book Company, 1984.
Useful Links	
1	https://nptel.ac.in/courses/112/105/112105123/
2	https://nptel.ac.in/content/storage2/courses/112104117/ui/Course_home-lec6.htm

CO-PO Mapping

	Programme Outcomes (PO)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3										1	2	2
CO2	3	2	1	2	3			3	3	1	3		2	2
CO3	3	2	1		2	1	1		3					1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher’s assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., SEM-VIII
Course Code	5ME438
Course Name	Product Lifecycle Management
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To provide the knowledge of different information systems used in an engineering enterprises
2	To impart the recent knowledge in the broader field of product development and various lifecycle aspects involved
3	To provide exposure to application of software tools for addressing problems in product design and development

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain various phases in product life cycle and its considerations in product development	III	Applying
CO2	Discuss PLM backend technologies and its implementation	IV	Analyzing
CO3	Apply DFX principles for product development	V	Evaluating

Module	**Module Contents**	**Hours**
I	**Introduction** Globalization and international business, Global competitiveness and manufacturing excellence, Operating environment, Business challenges, Emergence of information Age, Data and information management, Role of information systems.	6
II	**PLM evolution** Pre-PLM era, Sequential engineering, Concurrent engineering, Integrated product process development (IPPD),DFX, Design for manufacturability, Design for assembly, Design for disassembly, Design for environment	7
III	**Product Lifecycle Management** PLM Need, PLM overview, PLM system architecture, PLM functionalities, PLM systems and its benchmarking	6
IV	**Pillars of PLM systems** Computer aided design (CAD), Product data management (PDM), Enterprise	7

	resource planning (ERP), Supply chain management (SCM), Customer relationship management (CRM), Knowledge management (KM)	
V	**PLM and Database Management System** Database modeling (relational, object-oriented models, web models), Database systems (i.e., databases and rule management), Data warehousing, Databases and WWW, XML databases, Information retrieval, Distributed databases, Heterogeneous databases and data integration	6
VI	**PLM implementation** PLM implementation, Challenges, Data Interpretability, Business Process Reengineering, PLM implementation case studies.	7

Text Books	
1	Stark John, Product Lifecycle Management - 21st Century Paradigm for Product Realization, Springer, 2005.
2	Hoffer J, Prescott M, McFadden F, Modern Database Management, Prentice Hall, 2007.

References	
1	Ramakrishnan R and Gehrke J, "Database Management Systems", McGraw-Hill Publisher, 2002.
2	Kusiak A, "Concurrent Engineering: Automation, Tools, and Techniques", John Wiley & Sons, 1993.
3	Magrab E, Gupta S, McClusky P, Sandborn P, "Integrated Product and Process Design and Development: The Product Realization Process", CRC Press, 2010.

Useful Links	
1	https://nptel.ac.in/courses/106/106/106106220/
2	https://www.youtube.com/watch?v=LW8TMDwhc7w&list=PLeL2LKQLdbQvCnxVaL8WENwBPtQqTUTm4
3	www.odoo.com/cloud/plm-software

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2					3			3			1	3	
CO2	2			3				3					2	
CO3			2		2									1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.
ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	5ME439
Course Name	Mechanical System Design
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To prepare the students to succeed as designer in industry/technical profession.
2	To Provide students with a sound foundation in mechanical system design required to solve the problems in industry.
3	To train the students for safe and efficient design of structural parts of the mechanical system.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain the theory of pressure vessels and gearbox design.	III	Applying
CO2	Use Johnson's method of optimum design to design mechanical components.	IV	Analyzing
CO3	Estimate the tolerances and reliability of mechanical components and systems.	V	Evaluating

Module	**Module Contents**	**Hours**
I	Introduction to optimum design for mechanical elements, adequate and optimum design, Johnson's method of optimum design- simple problems in optimum design like axially loaded members, shafts subjected to torsional and bending moments, helical spring, levers. Optimum design with in Lagrange multipliers	6
II	(a) Statistics in design, probability, random variables- sample and populations, Normal distribution, Sampling distribution, Confidence intervals, population combinations (Introductory treatment, no questions to be asked in examinations on 5(a) (b) Design for natural tolerances, Statistical analysis of tolerances. Introductions to reliability and its applications for selections of factor of safety, study of process capability for design.	7
III	System Approach to Design; Mathematical model; Lumped system; Dynamic response of lumped & distributed system; Modeling of masses, Elasticity, Inertia, Damping and friction.	7

IV	Thin and thick cylinders; failure criteria of vessels; Lame's equation; Clavarino's and Birnie's equation; Autofrettage and compound cylinders; Types of pressure vessels-Horizontal and vertical; Classification of pressure vessel as per IS2825, 1969.Introdduction to design of pressure vessels as per IS Codes. Shell and end closures. Effect of opening & nozzles in shell & covers. Types of pressure vessel support	7
V	Determination of variable speed range- Graphical representation of speeds- Structure diagram- Deviation diagram- Ray diagram- Selection of optimum ray diagram- Difference between number of teeth of successive gears in a change gear box- Analysis of twelve speed gear box- Compound ray diagram	6
VI	Approach to industrial product based on idea generation and innovations to meet the creative process involved in idea marketing, designers, mind-criticism, design process, creation needs of the developing society. Design and development process of industrial products, various steps such as Ergonomics and aesthetic requirements of product design, quality and maintainability consideration in product design, Use of modeling technique, prototype designs, conceptual design	7

Text Books	
1	V. B. Bhandari , "Design of Machine Element", Tata Mc- Graw Hill Publication , 4th Edition, 2001
2	Shigley and C. R. Miscke , "Mechanical Engineering Design", Tata Mc- Graw Hill Publication, 2001
3	M. F. Spotts , "Mechanical design analysis", Prentice Hall publication, 1964
4	Black P. H. and O. Eugene Adams , "Machine Design", Tata Mc- Graw Hill Publication, 3rd Edition, 1993
5	W. H. Mayall ,"Industrial Design for Engineers", Illife, 1967

References	
1	M. V. Joshi, " Process Equipment Design" , Macmillan Publication, 1976
2	Robert L. Norton , "Machine Design", Tata Mc- Graw Hill Publication, 2001
3	Anurag Dixit , "Mechanical System Design" , SCITECH publication, 2005
4	Percy H. Hill "The Science of Engineering Design", Holt McDougal, 1970.

Useful Links	
1	https://nptel.ac.in/courses/112/105/112105124/
2	https://onlinecourses.nptel.ac.in/noc20_ch17/preview

CO-PO Mapping

	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3		2									3	3	
CO2			2					2				2	2	2
CO3		2	1	1										1

The strength of mapping is to be written as 1: Low, 2: Medium, 3: High
Each CO of the course must map to at least one PO.

Assessment

The assessment is based on MSE, ISE and ESE.
MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Third Year B. Tech., Sem. V
Course Code	5OE330
Course Name	Energy Engineering
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 2			

Course Objectives

1	To introduce students about alternate energy sources, their importance, needs, global scenario and economic considerations.
2	To provide knowledge of solar, bio, wind and ocean energy plants and its design methodology.
3	To prepare the students to analyze the performance and economics of thermal energy systems.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Discuss global energy scenario and energy systems	II	Understand
CO2	Distinguish and analyze solar, wind and bio mass as alternate sources of energy.	III	Apply
CO3	Assess the performance and economic considerations of energy systems.	IV	Analyze

Module	**Module Contents**	**Hours**
I	**Introduction to Non-Conventional Energy Sources** Introduction, Indian and global energy scenario, fossil fuels, India's energy production, consumption and demand of energy, solar energy and other non-conventional energy resources, role of alternate energy sources of worlds power generation in future	3
II	**Solar Energy** Extra-terrestrial solar radiation, solar radiation on earth, beam and diffused radiation, global radiation on a surface, solar radiation geometry, solar energy collectors, solar energy storage, solar pond, applications of solar energy, cooking, pumping, distillation, solar PV energy generation	5
III	**Wind Energy Conversion Systems** Wind data and energy estimation, availability of wind energy and wind velocity, site selection, basic wind energy conversion systems, types of wind machines, performance of wind m/c, energy storage, and applications of wind energy	5
IV	**Bio-Energy and Fuel cell**	5

	Bio-mass and photosynthesis, biogas generation, types of biogas plants, factors affecting biogas generation, community biogas plants, biogas digester design, design of community biogas plant for a village, problems related to biogas plant Fuel cells- Design and principle of Operation of a fuel cell, Classification and types of fuel cells, Advantages and Disadvantages of Fuel Cell, Applications of Fuel Cells, Batteries- Basic Batteries Theory, Classification of Batteries	
V	**Ocean Energy** Ocean thermal energy conversion (OTEC): principle of OTEC, open and closed cycle OTEC, working fluids for OTEC Tidal energy: principle of tide generation, tidal power plants, estimation of energy from tides, site selection for tidal power plants	4
VI	**Energy Economics and Environment** Life cycle costing, present worth factor, present worth of capital and maintenance cost, energy conservation opportunities, energy audit, co-generation systems, waste heat utilization, impact of conventional energy use on environment	4

Text Books	
1	G. D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, 5th Edition, 2014
2	V. M. Domkundwar, "Solar Energy and Non-Conventional Energy Sources", Dhanpat Rai & Co. Ltd., 1st Edition, 2010
3	R. K. Singal, "Non-Conventional Energy Sources", Katson Publication, 2nd Edition, Reprint, 2013

References	
1	Jhon Twidell and Tony Weir, "Renewable Energy Resources", Roultledge Publication, 2nd Edition, 2005
2	S. P. Sukhatme, "Solar Energy", McGraw Hill Publication, 4th Edition, 2017
3	G. S. Sawhney, " Non-Conventional Resources of Energy", PHI Publication, 5th Edition, 2012
4	Recent reports of agencies: International Energy Agency (IEA), Ministry of New and Renewable energy (MNRE), Technology and Action for Rural Advancement (TARA)

Useful Links	
1	https://mnre.gov.in/
2	https://beeindia.gov.in/
3	https://ascelibrary.org/journal/jleed9
4	https://onlinecourses.nptel.ac.in/noc21_ch11/preview

Civil

CO-PO Mapping														
	Programme Outcomes (PO)												**PSO**	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1						1					1		
CO2	1	1			1		1					1		
CO3	2	1	2		1		1					1		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High														

Electronics

CO-PO Mapping

	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2											1			
CO2	1	1			1		1					1			
CO3	1	2	2		1		1					1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Electrical

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2						2					1			
CO2	2	1			1		1					1			
CO3	2	2	2		1		1					1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Computer Science

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2														
CO2	1	1			1										
CO3	1	1	2		1										
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Information Technology

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2														
CO2	1	1			1										
CO3	1	1	2		1										
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Third Year B. Tech., Sem. V
Course Code	5OE329
Course Name	Non-Conventional Machining Processes
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To learn about various nonconventional machining processes the various techniques, performance characteristics and their applications
2	To introduce students with various machine tools and their peculiars used for nonconventional machining.
3	To train the students to identify main variables of nonconventional machining processes and to judge their effect on developed product.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Explain various nonconventional machining processes, tooling and equipment's required for various manufacturing applications.	II	understanding
CO2	Exploit the capabilities and applications of nonconventional machining processes.	III	Apply
CO3	Analyze effect of different parameters influencing on nonconventional machining processes and compare with other technique applications.	IV	Analyze

Module	**Module Contents**	**Hours**
I	**Introduction:** Introduction to nontraditional machining methods -Need for non -traditional machining -Sources of metal removal Classification on the basis of energy sources -Parameters influencing selection of process.	6
II	**Mechanical Type AMPs:**	7

	Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining – Ultrasonic Machining.(AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters– MRR- Applications	
III	**Thermal Type AMPs:** Electric Discharge Machining (EDM)- working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications-Micro-EDM, Micro-WEDM.	7
IV	**Chemical Type AMPs:** Chemical machining and Electro-Chemical machining (CHM and ECM)-Etchants – Maskant -techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications .Principles of ECM- equipments-Surface Roughness and MRR, Electrical circuit-Process Parameters- ECG and ECH – Applications	7
V	**Medium Assisted AMPs:** Laser Beam Machining: Material removal mechanism, types of Lasers, LBM equipment, process characteristics, applications. Electron Beam Machining: Basic equipment and metal removal mechanism, process characteristics, applications. Plasma Beam Machining: Machining systems, material removal rate, accuracy and surface quality, applications. Ion Beam Machining: Introduction, material removal rate, accuracy and surface effects, applications	7
VI	**Advanced MPs:** Basics and definitions: Principle of layer-based technology, advantages, classification. Rapid Prototyping Process Chain: 3D Modeling, Data Conversion and Transmission, Checking and Preparing, model building, post processing. Rapid prototyping techniques: Stereo lithography, Solid Ground Curing (SGC), Fused Deposition Modeling (FDM)	6

Text Books	
1	Mishra, P. K., Non-Conventional Machining, The Institution of Engineers (India), Text Book Series, New Delhi, 1997
2	Garry F. Benedict, Unconventional Machining Process, Marcel Dekker Publication, New York, 1987
3	Vijay.K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd, New Delhi, 2009.

References	
1	Hassan El-Hofy, "Advanced Machining Processes: Nontraditional and Hybrid Machining Processes", McGraw-Hill Co, New York (2005).
2	Benedict, Gary F., "Non-Traditional Manufacturing Processes", Marcel Dekker Inc., New York (1987)
3	Chua C. K. and Leong, Lim, "Rapid Prototyping Principles and Applications", 2nd edition, John Wiley and Sons.

Useful Links	
1	https://nptel.ac.in/courses/112/105/112105212/
2	https://nptel.ac.in/courses/112/103/112103202/
3	https://nptel.ac.in/noc/courses/noc16/SEM2/noc16-me15/
4	https://onlinecourses.nptel.ac.in/noc20_me17/preview

Civil

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2			2	2										
CO2	2	2			1				1	1					
CO3	2	2			1	1	1					1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Electronics

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2				2	2									
CO2	2	1			1	1	1					1			
CO3	2	2	2	2	1							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Electrical

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2			2								1			
CO2	2	2			2				1			1			
CO3	2	2		2	2							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Computer Science

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2			1	1	1									
CO2	2	2	1		2							1			
CO3	2	1	2		2							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Information Technology

CO-PO Mapping															
	Programme Outcomes (PO)												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2														
CO2	2	1			2				1						

CO3	1	2	2		2				1						
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Third Year, Sem VI
Course Code	5OE336
Course Name	3D Printing
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 2			

Course Objectives

1	To impart knowledge to the students on 3D printing technologies
2	To develop students to select material, process and application of 3D Printing.
3	To make students aware of software tools, processes and techniques of additive manufacturing.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Understand 3D printing process, data formats and software.	II	Understand
CO2	Select 3D printing techniques and materials.	III	Apply
CO3	Justify product quality and applications of 3D Printing in various domains.	IV	Analyze

Module	**Module Contents**	**Hours**
I	**Introduction to 3D Printing (Additive Manufacturing)** Overview, History, Process, Classifications, Advantages, Additive v/s Conventional Manufacturing processes	4
II	**CAD Model** CAD Data formats, Data translation, Data loss, STL format; CAD model preparation, Part Orientation and support generation, Model Slicing, Software features	4
III	**3D Printing Techniques** Stereo-lithography Apparatus (SLA), Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS), SLM, Binder Jet technology	6
IV	**Materials for 3D Printing** Polymers and their properties, Metals, Various forms of raw material- Liquid,	4

	Solid, Wire, Powder; Powder Preparation and their desired properties; Support Materials	
V	**Post Processing and Product Quality** Requirement and Techniques, Support Removal, Sanding, Acetone treatment, polishing; Inspection and testing; Defects and their cause	4
VI	**Application Domains** Aerospace, Electronics, Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools, Retail industry.	4

Text Books	
1	LiouW.Liou, Frank W.Liou, "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2	Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
3	CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
References	
1	T. A. Grimm & Associates, "Users Guide to Rapid Prototyping", Society of Manufacturing Engineers (SME) ISBN 0872636976, 2014.
2	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
3	C. E. Bocking, AEW Rennie, "Rapid & Virtual Prototyping & applications", Wiley Eastern, 2011.
Useful Links	
1	NPTEL and MOOC links

Civil

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1			2		2										
CO2			2		2							1			
CO3			2		2							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Electronics

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1			2		2										
CO2			2		2							1			
CO3			2		2							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Electrical

CO-PO Mapping		
	Programme Outcomes (PO)	**PSO**

	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1			2		2										
CO2			2		2							1			
CO3			2		2							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Computer Science

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1			2		2										
CO2			2		2							1			
CO3			2		2							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Information Technology

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1			2		2										
CO2			2		2							1			
CO3			2		2							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Third Year B. Tech., Sem. VI
Course Code	5OE337
Course Name	Basics of Automobile Engineering
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3 Hrs./week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To make students familiar with various basic of Engine and modern automobile.
2	To introduce the mathematical treatments required for vehicle performance and for some of important systems such as steering system and brake system.
3	To make students aware about latest trends in transportation towards a safe, pollution free and fully automatic vehicle.
4	To empower students to face the real life automotive usage with greater confidence.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Comprehend about I C Engines and various automotive systems and recent trends in automobile design, development, manufacturing and assembly.	II	Understand
CO2	Relate concepts of vehicle dynamics with daily experiences.	III	Applying
CO3	Analyze acceleration, barking and steering performance of a vehicle in different driving conditions.	IV	Analyze

Module	**Module Contents**	**Hours**
I	**Introduction, classification, Types of I C Engine.** Engine cycles, Combustion in SI & CI engines, Supercharging & emission control techniques, Engine performance parameters.	6
II	**Introduction, classification and Automotive power plants** Introduction, Broad classification of Automobiles. Major components and their functions. Types of vehicle layouts, Types of bodies. Requirements of automotive power plants, Comparison and suitability considerations. Engine cycles, Electric and Hybrid vehicles- Layout, advantages and limitations.	5
III	**Vehicle Performance** Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration,	7

	Gradeability and draw bar pull, Traction and Tractive effort, Distribution of weight, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio.	
IV	**Transmission System** Automobile clutch requirements, Types & functions, Single plate, Multi plate, Centrifugal and Fluid clutches. Requirements of gear box, Types of gearboxes, construction and Working Principle of operation of automatic transmission, Torque converter, Epicyclic gear train, Construction and working of Propeller shaft, Universal joint, Final drive, Differential, Rear axles.	6
V	**Suspension, Steering, Braking and Electrical System** Suspension requirements, Sprung and Unsprung mass, Types of automotive suspension systems. Conventional and Independent systems, Shock absorber. Types of springs, Hotch- kiss and Torque tube drive, Reaction members-Radius rods, Stabilizer bar, Air suspension system. Function of steering, Steering system layout, Automotive steering mechanism, Types of steering gear boxes, Condition for true rolling, Steering geometry-Camber, Caster, King pin inclination, Toe-in and Toe-out, Wheel alignment, Slip angle, Under steer & over steer conditions, Introduction of power steering, Function of automotive brake system, Types of braking mechanism, internal expanding & Disc brake, Mechanical, Hydraulic & Air brake system, Servo and power brakes, Calculation of braking force required, stopping distance and dynamic weight transfer Automotive batteries, Automotive lighting system, Starting system, Charging system, Voltage and current regulator, Electric horn, Dashboard gauges, Wiper & side indicator circuit, Engine electronic control modules, Safety devices.	10
VI	**Recent trends in Automotive Development** NVH and crashworthiness of vehicles, Emission norms and control, Testing and certification of vehicles. Introduction to Electric and Hybrid power trains.	5

Text Books	
1	V Ganesan, “Internal combustion Engine”, McGraw Hill Education ,4th Edition, 2012
2	Kripal Singh, “Automobile Engineering Vol. II”, Standard Publishers Distributors, Tenth Edition , 2007
3	P S Gill, “Automobile Engineering II”, S K Kataria and Sons, Second Edition, 2012
4	R K Rajput, “Automobile Engineering”, Laxmi Publications, First Edition, 2007
References	
1	John B Heywood, “Internal Combustion Engines fundamentals”, McGraw-Hill, Revised 2nd Edition, 2017
2	Newton, Steeds and Garrett, “The Motor Vehicle”, Butterworths International Edition, 11th Edition, 1989
3	Crouse and Anglin, “Automotive Mechanics”, McGrawhill Publication, Tenth Edition, 2007
4	P W Kett, “ Motor Vehicle Science Part - 2, “ Chapman & Hall” , 2nd Edition, 1982
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_me69/preview
2	https://nptel.ac.in/courses/107/106/107106088/
3	https://nptel.ac.in/courses/107/106/107106080/
4	https://ed.iitm.ac.in/~shankarram/Course_Files/ED5160/ED5160_Journal_Complete_Notes.pdf

CO-PO Mapping															
	Programme Outcomes (PO) Civil												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1		1	1								1				
CO2	1	1		1											
CO3		1		2								1			
	Programme Outcomes (PO) Electrical												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1			2								1				
CO2	3			2											
CO3		3		2								1			
	Programme Outcomes (PO) Electronics												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1		2	2								1				
CO2				1											
CO3		1		2								1			
	Programme Outcomes (PO) Information technology												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1		1									1				
CO2		1		1											
CO3				1								1			
	Programme Outcomes (PO) Computer science and engineering												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1		1	1								1				
CO2		1		1											
CO3												1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3. ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO. ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6. For passing a theory course, Min. 40% marks in (MSE+ISE+ESE) are needed and Min. 40% marks in ESE are needed. (ESE shall be a separate head of passing)

Walchand College of Engineering, Sangli

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AY 2022-23

Course Information

Programme	B. Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem. VII
Course Code	5OE429
Course Name	Industrial Automation
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**MSE**	**ISE**	**ESE**	**Total**
Tutorial	-	30	20	50	100
		Credits: 3			

Course Objectives

1	To train the students in the area of instrumentation, automation and control.
2	To get the basic knowledge and practical experience in instrumentation, automation and control area and to work more effectively in manufacturing, process and automation industries
3	To get the knowledge of various elements of industrial automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC.

Course Outcomes (CO) with Bloom's Taxonomy Level

At the end of the course, the students will be able to,

CO	**Course Outcome Statement/s**	**Bloom's Taxonomy Level**	**Bloom's Taxonomy Description**
CO1	Identify different types automation, technological and economic issues involved in automatic manufacturing of products	III	Apply
CO2	Interpret basic concepts of sensors and transducers into real world applications.	V	Evaluate
CO3	Classify the major components used in automation such as commonly used sensors and analyze common techniques for sensor interfacing and protection circuits	IV	Analyze

Module	**Module Contents**	**Hours**
I	**Introduction to Automation** Introduction: Reason of automation, Current trends, classification and types of automation, Application of automation, Goals of automation, Low cost automation, Current emphases in automation, Issues for automation in factory operation, Ten strategies for automation.	6

II	**NC and CNC** Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centres, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing.	6
III	**Computer Aided design** Computer Aided Design: Fundamentals of CAD - Hardware in CAD- Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, CNC Adaptive Control	7
IV	**Automation Elements** Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies.	7
V	**Sensors and Processors** Introduction, Sensor and transducers, Sensor technology, Selection of Transducers, Classification of sensors and transducers, History of Microprocessor, Programmable logic controller, Working of PLC.	7
VI	**Modelling and Simulation** Introduction to Modelling and Simulation: Product design, process route modelling, Optimization techniques, Case studies & industrial applications	6

Text Books	
1	Mikell P. Groover, "Automation, Production systems and computer integrated manufacturing", Prentice Hall, 5th edition, 2019.
2	Serope Kalpakjain and Steven R. Schmid, "Manufacturing Engineering and Technology", 7th edition, Pearson, 2014.
3	Ibrahim Zeid, CAD/CAM : Theory & Practice, 6th edition, 25 June 2009.

References	
1	Yoram Koren, "Computer control of manufacturing system", McGraw Hill, 1st edition, 2017
2	Webb and Reis, "Programmable Logic Controller – Principles and Applications", Prentice Hall of India, 5th Edition, 2002
3	Kolk R.A. and Shetty Devdas, "Mechatronics System Design", Thomson Learning, 2007, 3rd Edition

Useful Links	
1	https://nptel.ac.in/courses/112/103/112103293/
2	https://onlinecourses.nptel.ac.in/noc20_me58/preview
3	https://nptel.ac.in/courses/112/104/112104288/
4	https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-me58/

Civil

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2				1	1									
CO2	2	1			2		1		1			1			

CO3	2	1	2		1							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Electronics

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2		1		1										
CO2	2	2			2							1			
CO3	2	2	1		1		1					1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Electrical

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2		1	1											
CO2	2	1			1		1					1			
CO3	2	1	2		1							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Computer Science

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2	1			1	1									
CO2	2	1			2				2			1			
CO3	2	2	2		1							1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Information Technology

CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	2														
CO2	2	1		1	1				1			1			
CO3	2	1	2		1				1			1			
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment
The assessment is based on MSE, ISE and ESE. MSE shall be typically on modules 1 to 3.

ISE shall be taken throughout the semester in the form of teacher's assessment. Mode of assessment can be field visit, assignments etc. and is expected to map at least one higher order PO.
ESE shall be on all modules with around 40% weightage on modules 1 to 3 and 60% weightage on modules 4 to 6.
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