Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	
Course Name	Solid Mechanics
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To provide students a sound knowledge in solid mechanics 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,

CO1	Explain the concept of theory of elasticity	Apply
CO2	Show basic relations between stress and strains from theory of elasticity perspective and use energy methods to solve structural problems.	Analyze
CO3	Analyse the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.	Evaluate

Module	**Module Contents**	**Hours**
I	Concept of Stress, Components of stress, Principal stresses, Stress invariants, Principal planes, Octahedral Stresses, Cauchy Stress, Differential equations of equilibrium, Equations of equilibrium in cylindrical coordinates	7
II	Concept of strain, Deformations in the neighborhood of a point, Change in length of a linear element, The state of strain at a point, Interpretation of shear strain components,Principal axes of strain and principal strains, Plane strains in polar coordinates, Compatibility conditions.	7
III	Generalized statement of Hooke's law, Stress-strain relations for isotropic materials, Relation between the elastic constants, Plane Stress and Plane strain, Mohr's circles for the 3-D state of stress, Strain Measurement	6
IV	Energy Methods, Work done in deformation, Reciprocity theorem, Castigliano theorem, Principle of virtual work, Principle of minimum potential energy, Rayleigh- Ritz method	7
V	Bending of Beams, Straight beams and asymmetrical bending, shear center or center of flexure, shear stresses in thin walled open sections	6
VI	Application to thick cylinders and rotating discs, torsion of non-circular cross-sections, Thermo-elasticity, 2-D contact problems, Introduction to plasticity.	7

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Analyse state of stresses 3-D continuum.
2. Analyse state of strains in a 3-D continuum.
3. Establish stress-strain relations for deformable solids.
4. Analyse mechanical structures using energy methods.
5. Evaluate stresses in symmetrical and asymmetrical beams.

6.	Evaluate the stresses in the different applications by using theory of elastcity concepts.
Text Books	
1	S.P. Timoshenko and J.N. Goodier, "Theory of Elasticity", McGraw-Hill Publishing Co. Ltd., 3rd Edition, 1970.
2	2. Beer and Johnston, "Mechanics of Materials", McGraw Hill, 6th Edition , 2012
3	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	
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CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												2		
CO2			2								3	3	2		
CO3	2		2									3	3		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment (for Theory Course)
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

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AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B.Tech., Sem VII
Course Code	
Course Name	Project I and Seminar
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	6 Hrs/Week	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To help students to address real life challenges and discuss project requirements.
2	To give technical solutions through latest design & development tools.
3	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.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Understand the importance of teamwork and will be able to work in a team for achieving group goals / will be prepared to assume a leadership role in any team.	Understand
CO2	Explain various concepts and tools used in their project and analyze and give solutions for a specific problem statement related to their project.	Analyse
CO3	Prepare and present a detailed report based on project work spread over two semesters.	Creating

List of Experiments / Lab Activities

Course Contents:

1. **Project Definition:-**
   - Creation of product, apparatus, small equipment, test setup, experimental setup.
   - Prototype based on new ideas, innovation of existing products.
   - Energy audit/ conservation-studies of department/ section / organization / plant / 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.
   - Industry sponsored projects.

Project work to be taken up individually or in group (a group shall not be more than 5 students).

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

2. Synopsis:-

Synopsis should contain:-

a. Need of project- How you / your group inspired of particular project
b. Aim and objective of project topic.
c. Idea / ideas used in the project work.
d. How will you or your group 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 (July to March).
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.

3. 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.

Text Books	
1.	Various printed and electronic resources available on the internet and institute library.

References	
1.	All types of standard journals, conference proceedings etc.

Useful Links	
1	Online resources in the selected domain areas.

CO-PO Mapping

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

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

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.

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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40

Week 1 indicates the starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	15	10	10	**35**
Apply				
Analyze	10	10	10	**30**
Evaluate				
Create	5	10	20	**35**
Total Marks	**30**	**30**	**40**	**100**

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Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To introduce the basics and application of Finite Element Method
2	To explain the general steps in finite element method.
3	To solve various field problems using finite element method.
4	To illustrate the principle of mathematical modeling of engineering problems

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain the use of mathematical modeling and FEM.	Apply
CO2	Formulate finite element problem	Analyze
CO3	Analyse structural and thermal problems using finite element technique.	Evaluate

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	Governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method.	7
III	One dimensional second order equation, discretization, linear and higher order elements, derivation of shape functions, Stiffness matrix and force vectors, assembly of elemental matrices, solution of problems from solid mechanics and heat transfer, fourth order beam equation, transverse deflections, continuity	7
IV	Two dimensional equations, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors; application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements.	7
V	Introduction, co- ordinate transformations, natural coordinates, isoparametric elements, Numerical integration, 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, longitudinal vibration and mode shapes, solution of dynamic problems	7

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1.	Explain the use of mathematical modeling and FEM.
2.	Apply the general steps of finite element method to solve engineering problems.
3.	Use the discretization techniques to mesh the various geometries.
4.	Solve the structural, thermal and fluid problems using variational formulation methods.
5.	Describe the various boundary conditions.
6.	Interpret the finite element model and its simulation results.

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. PHI publication. Ltd., 2008.
3	M. J Fagan, "Finite Element Analysis- Theory and Practice"; Longman Scientific & Technical, 1st

References	
1	J. N. Reddy, "An Introduction to Finite Element Method", Tata McGraw Hill publication co. 2nd Edition, 1993
2	2. Logan D. L. "A first course in Finite Element Method", Cengage learning, 4th Edition, 2008.
3	3. O. C, Zienkiewicz "The Finite Element Method – Basic Concepts and Linear Applications", Tata McGraw Hill publication co., 5th Edition, 2000.

Useful Links	
1	
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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			
CO2			3	2				2					2		
CO3		2						2				2	2		

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

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AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To introduce various prediction methods and CFD methodology
2	To introduce governing Equations of fluid flow and its numerical modelling.
3	To enable the students to understand the various boundary conditions, discretization methods, and solution procedures.
4	To prepare the students to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Interpret prediction methods, CFD methodology and its Applications.	Apply
CO2	Derive and explain the different forms of governing equations	Analyze
CO3	Apply the numerical techniques to solve various engineering problems.	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction** Prediction method, experimental techniques, analytical methods, CFD application, typical problems/ Problem Solving with CFD – Methodology.	6
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 behaviour.	7
III	**Solution of the Navier-Stokes equations and boundary conditions** Exact solution of the Navier-Stokes equations, Transformation of the Governing Partial Differential Equations, Grid Generation Techniques, Boundary conditions: Introduction, types of boundary conditions, Potential pitfalls and final remarks	6
IV	**Basic computational techniques for simple grids** Finite Difference Formulations: Introductory remarks, Taylor Series Expansions, Finite difference by Polynomials, Finite difference equations, Applications. Finite Volume Method: Introduction, Steady one-dimensional problem, Properties of discretization schemes, 1-D examples	7
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 Maccormacks 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 numeric: Integral values, Drag, lift, torque calculations	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Describe and recall basics of fluid mechanics and mathematics, methods of prediction and applications of CFD
2. Derive various governing equations in fluid mechanics and heat transfer, interpretation of these equations.
3. Understand the exact solutions of N S equations, types of grid generation techniques and boundary conditions.
4. Analyze the FDM and FVM methods; carry out the solution using these methods.
5. Select the appropriate solution method, analyze and check the CFD study
6. To select the appropriate post processing method, carry out and compare the various results.

Text Books	
1	Anderson, J.D., "Computational Fluid Mechanics The Basics with applications", McGrawHill Publication 1995
2	H.K.Versteeg and W Malalasekera, "Introduction to Computational Fluid Dynamics" Longman Group Ltd 1995
3	Subas V. Patankar"Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980

References	
1	Taylor, C and Hughes J.B. "Finite Element Programming of the Navier Stock Equation", Pineridge Press Ltd., U.K.1981.
2	Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer-Verlag, 1987.
3	Flectcher, C.A.J., "Computational Techniques for Different Flow Categories", Springer-Verlage 1987.

Useful Links	
1	
2	

CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		T1	T2	ESE	Total
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**

4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

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AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	
Course Name	Foundry Technology
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To provide knowledge of various phenomena observed in liquid metals and its effect on casting quality
2	To make students familiar with the concepts related to casting solidification to get homogeneous and sound casting
3	To impart knowledge for design of gating and feeding system
4	To demonstrate the melting practices and various equipments used in modern foundries

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Summarize the foundry processes / equipments and metallurgical aspect of casting processes	Apply
CO2	Calculate the dimensional aspects of gating system, cooling rate and furnace charging	Analyze
CO3	Investigate the phenomenon observed during metal liquefaction, pouring, solidification, and their effects on casting quality	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction** Brief History, Foundry Metallurgy: Oxidation of liquid metals, gas dissolution in liquid metals, methods of degassing, fluidity, factors affecting fluidity, fluidity tests, hot tearing, shrinkage of liquid metals.	6
II	**Solidification of Casting** Crystallization and development of cast structure, Nucleation, Growth, Dendritic growth, Independent nucleation, Eutectic freezing, Peritectic reactions, The structure of castings, Concept of progressive and directional solidification, Chvorinov's equation, heat flow analysis	7
III	**Feeding of Castings** Characteristics, gating technique, casting temperature and pouring speed, use of chills, padding and insulators, feeding and gating system design	7
IV	**Melting of Ferrous Alloys** Melting Practices: cupola: charge calculations, construction; other furnaces: working ofinduction furnace, crucible furnace, and reverberate furnace.	6
V	**Modernization and Mechanization of Foundry** Need for modernization, and mechanization, moulding and core making, melting, pouring, shake out equipment and fettling, dust and fume control, material handling equipment for sand moulds and cores, molten metal and castings, reclamation of sands ,Pollution control.	7
VI	**Modern Developments** Recently developed processes, Foundry Management, Energy conservation	6

	methods, Casting simulation, DFM for cast components, Emerging techniques of Rapid prototyping and tooling, Simulations and analysis software's.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. 1. Describe high temperature behavior of metals
2. 2. Articulate phases in casting solidification, related defects and remedial action to eliminate the defects
3. 3. Solve the problems related to gating and feeding system design
4. 4. Explain the melting practices and the equipment involved
5. 5. Discuss various modern equipment used in foundry
6. 6. Examine the design from casting production or yield point of view

Text Books	
1	P. L. Jain, "Principle of Foundry Technology",5th edition, Tata McGraw Hill publishing Co.Ltd.,2017, ISBN:9780070151291.
2	.T V Ramana Rao, "Metal Casting: Principles and Practice", 2nd edition , New Age International (P) Ltd Publishers,2020,ISBN: 9789388818162
3	B. Ravi, "Metal Casting Computer Aided Design and Analysis" Prentice Hall of India, New Delhi, 2005.

References	
1	Richard Heine,Carl Loper & Philip Rosenthal, "Principles of Metal Casting", Tata McGraw Hill publishing Co.Ltd,Indian edition, 2017,ISBN-10 : 0070278962; ISBN-13 : 9780070278967
2	P.Beelay, "Foundry Technology", Butterworth-Heinemann, 2001,ISBN:9780750645676(print book) 9780080506890 (ebook)
3	D M Stefanescu,"ASM Handbook, Volume 15: Casting", 2001. ISBN-10 : 9780871700216,ISBN-13 : 978-0871700216

Useful Links	
1	
2	

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				1		
CO2			2									1	2		
CO3		3						2						2	

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

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AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To make the students perform in industry for effective planning, controlling, and implementing projects.
2	To utilize the principles of science, technology and engineering for solving industry relevant problems.
3	To develop managerial skills relevant to the industry.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain recent trends in industrial engineering.	Apply
CO2	Illustrate the basic concepts of modern industrial engineering in the manufacturing and service sector.	Analyze
CO3	Examine various method study, work measurement and inventory management techniques.	Evaluate

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.	7
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 equipment, 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** Definitions, objectives, activity and elements, performance rating, rating methods, allowances, group timing techniques, work sampling, PMTS.	6
V	**Inventory Control** Different Models of Inventory Systems, Economic order quantity, 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 Limited , N. Delhi, 3rd revised edition 2018

3	M. Mahajan, " Industrial Engineering and Production Management", Dhanpat Rai & Co., Modified Edition, 2010
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	3
CO1					2				3				3		
CO2				3	1	2							2	2	
CO3					2		2	3						3	
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment (for Theory Course)
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

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

Course Objectives

1	To explain the finite element method, its fundamentals and general steps.
2	To describe the underlying theory, assumptions and modeling issues in FEM.
3	To provide hands on experience using finite element software to model, analyze and design systems of mechanical engineering.
4	To provide hands on experience using finite element software to simulate structural, fluid and thermal

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Execute the structural, thermal and dynamic analysis using suitable software.	Apply
CO2	Categorize the mathematical methods and finite element procedures for engineering applications.	Analyze
CO3	Select the procedures for structural, thermal and fluid analysis of 1D, 2D and 3D problems.	Evaluate

List of Experiments / Lab Activities

List of Experiments:

Term work shall consist of minimum ten based on the topics given below.

The students are expected to solve (any 10) the problems by using any FEM software.

1. Analysis of stepped bar
2. Thermal analysis of composite wall
3. Torsional analysis of shaft
4. Analysis of truss
5. Problems on shape functions
6. Structural 2D analysis
7. Structural 3D analysis
8. Modal Analysis
9. Thermal 2D analysis
10. Thermal 3D analysis
11. Geometrical nonlinear analysis
12. Contact nonlinear analysis
13. Material nonlinear analysis
14. Industrial Visit to Software Company.

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, PHI publication, 2008.

3	M. J Fagan, “Finite Element Analysis- Theory and Practice”; Longman Scientific & Technical, 1st
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., 4th Edition.
Useful Links	
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CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2		3				3					2		
CO2		2		2				2					2		
CO3		2	2									1	3		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom’s Taxonomy Level (Marks) (For lab Courses)				
Bloom’s Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand				
Apply	10	10	15	**35**
Analyze	10	10	15	**35**
Evaluate	10	10	10	**30**
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

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

Course Objectives

1	To introduce the students about geometry creation, meshing boundary conditions, numerical techniques.
2	To prepare the students to use appropriate mesh, boundary conditions, and numerical technique.
3	To develop the skill to use high speed digital devices to solve CFD problems.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Interpret the methodology of CFD simulation	Understand
CO2	Explain FDM, FVM techniques and their significance, boundary conditions, grid generation techniques.	Understand
CO3	Select and apply the grids, boundary conditions, solver / numerical technique, post processing techniques etc.	Apply
CO4	Analyze and interpret the Preprocessing, Processing and Post Processing techniques/methods in CFD	Analyz

List of Experiments / Lab Activities

List of Experiments:

1. Methodology to simulate the problem with CFD.
2. Different types of grids and grid generation techniques.
3. Different types of boundary conditions.
4. Simulation of 1D conduction problem using FDM.
5. Simulation of 2D conduction problem using FDM
6. Simulation of 1D conduction problem using FVM.
7. Simulation of 2D conduction problem using FVM
8. Simulation of mass diffusion problem using FVM.
9. Simulation of flow through pipe using - commercial software.
10. Simulation of flow through orifice meter / Venturimeter.
11. Flow around Cylinder/Sphere/ Aerofoil.
12. Simulation of flow through duct.
13. Simulation of forced convection heat transfer problem.
14. Simulation radiation heat transfer problem.
15. Simulation of flow and heat transfer through porous media.
16. Simulation of Parallel flow heat exchanger.
17. Simulation of Counter flow heat exchanger.
18. Simulation of phase change phenomenon.
19. Simulation of flow in Turbomachines.
20. Simulation of unsteady state heat transfer problem.

Text Books	
1	Anderson, J.D., “Introduction to Computational fluid Dynamics”, McGrawHill Publication 2008
2	Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, 2nd edition, New Delhi 2011.
3	H.K.Versteeg and W Malalasekera, “Introduction to Computational Fluid Dynamics” Longman group, 1998.
4	Hoffmann K.A “ Computational fluid Dynamics” Publication of engineering education system 2000
References	
1	Anderson, J.D., “Introduction to Computational fluid Dynamics”, McGrawHill Publication 2008
2	Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, 2nd edition, New Delhi 2011.
3	H.K.Versteeg and W Malalasekera, “Introduction to Computational Fluid Dynamics” Longman group, 1998.
Useful Links	
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CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2											1	2	
CO2	3	2	1		3			3	3		3		1	2	
CO3	3	2	3		2	1			3				1		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom’s Taxonomy Level (Marks) (For lab Courses)				
Bloom’s Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	10	10	15	**35**
Apply	10	10	15	**35**
Analyze	10	10	10	**30**
Evaluate				
Create				

Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

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

Course Objectives

1	To make students familiar with important sand properties and its effect on casting quality
2	To avail hands on experience with metal casting/foundry practices
3	To impart practical knowledge in design of gating and feeding system for cast component
4	To provide exposure to computer applications in found
5	To give students an exposure to various equipment used in foundries.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Examine the cast products, Foundry Processes, and computer application involved therein	Understand
CO2	Attribute the Sand Properties and investigate the Casting Defects	Understand
CO3	Design the gating, feeding system, patterns and furnace charge	Apply

List of Experiments / Lab Activities

List of Experiments:

I. Sand testing lab (8 hrs)
a. Compressive strength of molding sand (1 hrs)
b. Tensile strength of molding sand (1 hrs)
c. Shear strength of molding sand (2 hrs)
d. Permeability test for molding sand (2 hrs)
e. Sieve shaker experiment to find GFN for molding sand (2 hrs)

II. Simple metal casting job (10 hrs)
a. Design of feeder
b. Design of gating system
c. Pattern design and pattern manufacturing
d. Mold preparation and pouring

III. Study of Cupola furnace (2 hrs)

IV. Demo on metallography of standard cast samples (2 hrs)

V. Computer applications(6 hrs)
a. Computer program for foundry charge calculation (2 hrs)
b. Demo of casting design and analysis in simulation software (4 hrs)

VI. Foundry(ferrous and non-ferrous) visits and reports

Text Books	
1	P. L. Jain, "Principle of Foundry Technology",5th edition, Tata McGraw Hill publishing Co.Ltd.,2017, ISBN:9780070151291
2	P.N.Rao, "Manufacturing Technology-Foundry, Forming and Welding, 5th edition (Volume I)", Tata McGraw Hill publishing Co.Ltd.,2018,ISBN: 9353160510, 9789353160517
3	B. Ravi, "Metal Casting Computer Aided Design and Analysis" Prentice Hall of India, New Delhi, 2005.
References	
1	P.Beelay, "Foundry Technology", Butterworth-Heinemann, 2001,ISBN:9780750645676(print book) 9780080506890 (ebook)
2	D M Stefanescu,"ASM Handbook, Volume 15: Casting", 2001. ISBN-10 : 9780871700216,ISBN-13 : 978-0871700216 3. Stimpson William C, Gray Burton Linwood, " Foundry Work: A Practical Handbook on Standard Foundry Practice, Including Hand and Machine Molding; Cast Iron, Malleable Iron, Steel, and Brass Castings; Foundry Management; Etc.", Creative Media Partners, LLC, 2018,ISBN: 0343313146, 9780343313142
3	P.Beelay, "Foundry Technology", Butterworth-Heinemann, 2001,ISBN:9780750645676(print book) 9780080506890 (ebook)
Useful Links	
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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			2						1					1	
CO3			2						1				2		
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				

Understand	10	10	15	**35**
Apply	10	10	15	**35**
Analyze	10	10	10	**30**
Evaluate				
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

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

Course Objectives

1	To make the students perform in industry for effective planning, controlling, and implementing projects.
2	To utilize the principles of science, technology and engineering for solving industry relevant problems.
3	To develop managerial skills relevant to the industry.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain recent trends in industrial engineering.	Apply
CO2	Illustrate the basic concepts of modern industrial engineering in the manufacturing and service sector.	Analyze
CO3	Examine various method study, work measurement and inventory management techniques.	Evaluate

List of Experiments / Lab Activities

Case studies on:

1. Characteristics of manufacturing organization
2. Classification of services and service sectors
3. Sales forecasting
4. Capacity requirement planning
5. Types of plant layouts
6. Material handling system
7. Time study and motion study
8. Work measurement and performance rating
9. Inventory models and economic order quantity
10. Network techniques, CPM and PERT

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 Limited , N. Delhi, 3rd revised edition 2018
3	E.S. Buffa and R.K. Sarin, "Modern Production/ Operations Management, Wiley & Sons, 8th Edition, 2002

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	3
CO1					2				3				3		
CO2				3	1	2							2	2	
CO3					2		2	3						3	

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

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.

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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40

Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)

Bloom's Taxonomy Level	LA1	LA2	Lab ESE	Total
Remember				
Understand	10	10	15	**35**
Apply	10	10	15	**35**
Analyze	10	10	10	**30**
Evaluate				
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	
Course Name	Dynamics of Machines
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**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 understand single and two degree of freedom systems of vibrations.
4	To learn about torsional vibrations of 1, 2 and 3 rotor systems.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain the basics of vibration, causes and basic elements and its measurement	Apply
CO2	Apply numerical methods in finding natural frequency and corresponding mode shapes of systems	Analyze
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	Evaluate

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 and shock mounts	7
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.	7
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	5

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Understand the fundamental terms related to vibrations.
2. Explain different types of vibrations.
3. Analyze two degree of freedom system and forced vibrations.
4. Understand torsional vibrations of 1, 2 and 3 rotor systems.
5. Use mechanical vibration measuring instruments.
6. Analyze the rotor system for critical speed.

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

References	
1	Austin Church, "Mechanical Vibrations", Wiely Eastern, 1st Edition, 1963
2	Cyril M. Harris, Charles E. Crede, "Shock and vibration handbook", McGraw-Hill, 1st 1976
3	S. S. Rao, "Mechanical Vibrations", 4th Edition, 2006

Useful Links	
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CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**

4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	
Course Name	Gas Dynamics and Jet Propulsion
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To understand the basic difference between incompressible and compressible flow.
2	To understand the phenomenon of shock waves and its effect on flow.
3	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,

CO1	Understand the basic difference between incompressible and compressible flow.	Apply
CO2	Recognize phenomenon of shock waves and its effect on flow.	Analyze
CO3	apply gas dynamics principles in the Jet and Space Propulsion	Evaluate

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.	6
II	**FLOW THROUGH DUCTS** Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties	9
III	**NORMAL AND OBLIQUE SHOCKS** Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications	4
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.	7
VI	**PERFORMANCE STUDY** Performance study – Staging – Terminal and characteristic velocity – Applications – space flights.	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Understand basic concepts and isentropic flows.
2. Understand flow through ducts.
3. Understand normal and oblique shocks.
4. Understand the jet propulsion operating principle
5. Explain theory of rocket propulsion.

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

Assessment (for Theory Course)
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**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.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Apply concepts of CIM using robotics and automation.	Apply
CO2	Analyze the fundamental concepts of Automation and Product Development through CIM models	Analyze
CO3	Interpret CIM concepts in flexible manufacturing system.	Evaluate

Module	**Module Contents**	**Hours**
I	**Computer Integrated Manufacturing** Introduction, definition, importance, components, automation and evolution of CIM. Advantages, limitations, scope and globalization view. Product design and CAD/CAM, role of computers in design and manufacturing, Role of CAD/CAM in CIM.	6
II	**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	7
III	**Automated Quality Control** In-process and post process methodologies, integrations of CNC machines, robot in CIM environment. Communication, software/ Hardware: Availability of software, network topologies for LAN, network interface card and protocols, Network operating systems.	6
IV	**CIM models** Introduction, ESPRIT- CIM OSA model, the NIST- AMRF hierarchical model, the Siemens model, digital equipment corporation model, IBM concept of CIM.	7
V	**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	6
VI	**Flexible Manufacturing Systems in CIM** Flexible Manufacturing Systems: Concept, difference between rigid and flexible	7

	manufacturing, concept of cellular manufacturing, structure of FMS, components of FMS. Computer Aided Quality Control: Objectives, contact & non-contact inspection, types of contact and non-contact inspection, scope in CIMS, coordinate measuring machine :types, construction, working principle, working, applications, scope of CMM in CIMS, flexible inspection system.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Explain advancement in manufacturing systems.
2. Introduce the idea of CIM and its implementation.
3. Use appropriate software and related hardware.
4. Understand various CIM models and idea of IBM concept.
5. Use of robotics in CIM environment.
6. Implement CIM for flexible manufacturing systems.

Text Books	
1	Automation, Production systems and Computer Integrated Manufacturing by M.P.Groover, 1987.
2	Computer Integrated Design and Manufacturing by Bedworth, Henderson Wolfe (McGraw Hill), 1991
3	Performance Modeling of Automated Production System by Narhari and Vishvanandhan, 2015

References	
1	Urich Rembold, "Computer Integrated Manufacturing Technology and System," 1995.
2	Yorem koren, "Computer Integrated Manufacturing System", McGraw-Hill, 1983.
3	S. Kant Vajpayee, "Principles of Computer Integrated Manufacturing" (PHI), 2015

Useful Links	
1	
2	

CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		T1	T2	ESE	Total
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B.Tech., Sem VII
Course Code	
Course Name	Dynamics of Machines Lab
Desired Requisites:	

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

Course Objectives

1	To make students aware about causes and effects of the vibration on mechanical systems.
2	To demonstrate mechanical vibration measuring instruments
3	To develop the student's skills in un-damped, damped, free and forced vibrations.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Demonstrate the concept of vibration, its causes and basic elements and its measurement.	Understand
CO2	Determine the natural frequency, damping coefficient and other characteristics of a system.	Apply
CO3	Measure transmissibility characteristics of a system.	Analyz

List of Experiments / Lab Activities

List of Experiments:

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, 3rd Edition, 2006
2	Dr. V. P. Singh, "Mechanical Vibrations", S. Chand and Sons New Delhi, 2nd Edition, 2004
3	J. S. Rao, "Introductory Course on Theory And Practice of Mechanical Vibrations", New Age

References

1	Austin Church, “Mechanical Vibrations”, Wiely Eastern, 1st Edition, 1963
2	Cyril M. Harris, Charles E. Crede, “Shock and vibration handbook”, McGraw-Hill, 1st 1976
3	S. S. Rao, “Mechanical Vibrations”, 4th Edition, 2006
Useful Links	
1	
2	

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

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom’s Taxonomy Level (Marks) (For lab Courses)				
Bloom’s Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	10	10	15	**35**
Apply	10	10	15	**35**
Analyze	10	10	10	**30**
Evaluate				
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B.Tech., Sem VII
Course Code	
Course Name	Gas Dynamics and Jet Propulsion Lab
Desired Requisites:	

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

Course Objectives

1	To understand the basic difference between incompressible and compressible flow.
2	To understand the phenomenon of shock waves and its effect on flow.
3	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,

CO1	Understand the basic difference between incompressible and compressible flow.	Understand
CO2	Recognize phenomenon of shock waves and its effect on flow.	Apply
CO3	apply gas dynamics principles in the Jet and Space Propulsion	Analyz

List of Experiments / Lab Activities

List of Experiments:

List of experiments (study type)

1. Study of isentropic flows and numerical on stagnation properties.
2. Study of flow through ducts and numerical on Rayleigh and Fanno flow.
3. Study of normal and oblique shocks and numerical.
4. Study of jet propulsion and numerical.
5. Study of performance of rocket engines.
6. Visit to gas turbine power plant.

Text Books

1	P. K. Nag "Engineering Thermodynamics", Tata McGraw Hill Publication, 2017, 6th Edition
2	R. Yadav, "Fundamentals of Thermodynamics", Central Publication house, Allahabad, 2011, Revised 7th Edition

References

1	Cengel and Boles, "Thermodynamics an Engineering Approach", Tata McGraw-Hill publication, Revised 9th Edition, 2019
2	Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., "Fundamentals of Thermodynamics", John Wiley and Sons, 7th Edition, 2009
3	Moran, M. J. and Shapiro, H. N., "Fundamentals of Engineering Thermodynamics", John Wiley and Sons, 8th Edition, 1999

Useful Links

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

Assessment

There are three components of lab assessment, LA1, LA2 and Lab ESE.
IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.

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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40

Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	10	10	15	**35**
Apply	10	10	15	**35**
Analyze	10	10	10	**30**
Evaluate				
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

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

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.
4	To evolve prominent component of Automated Manufacturing Systems and controllers to perform a programmed tasks.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Demonstrate how CIM knowledge is useful in engineering and consumer products in day-to-day life.	Understand
CO2	Examine continuous-time control using software for the manipulation, transmission, and recording of data	Apply
CO3	Decide suitable actuators and sensors and integrate them with embedded control systems	Analyz

List of Experiments / Lab Activities

List of Experiments:

1. Introduction to various CIM models with case study
2. To demonstrate Robot anatomy and related attributes for different types of joints, links, configurations, drive and control systems, end effectors and sensors
3. Demonstration on fluid mixer in manufacturing
4. Study of software and hardware interfacing requirements in CIMS
5. Demonstration on automated belt conveyer system
6. To study and use of CIM for Flexible manufacturing systems
7. Demonstration on automatic bottle filling plant
8. Pick and place operation in industrial application
9. Demonstration on pneumatic operated resistance spot welding machine
10. Water level controller for industrial use
11. Use of stepper motor in industrial environment
12. Use of HMI for CIM
13. Demonstration on automatic spray painting machine
14. To study and demonstration on CMM
15. Generation of any one simple solid model using CAD software.

Text Books

1	Groover M. P. "Automation, Production Systems and Computer Integrated Manufacturing",

	Prentice Hall International publication, 2004.
2	Groover M. P., Nagel R.N., Ordey N.G. "Industrial Robotics- Technology, Programming and Applications," McGraw Hill International, 2012.
3	Pradeep Chaturvedi, N.K. Tewari, P.V. Rao, G.S. Yadav, "Modern Trends in Manufacturing
References	
1	Richard M. Murrai, Zexiang Li, S Shankar Sasrty, "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	
2	

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

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	10	10	15	**35**
Apply	10	10	15	**35**
Analyze	10	10	10	**30**
Evaluate				
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	
Course Name	Computer Aided Design (CAD)
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To familiarize the student with different modeling techniues used for component design.
2	To develop the students to use mathematical representation of geometries and different tolerance techniques.
3	To make students aware of use of computer for data exchange formats and tools.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain different modeling techniques.	Apply
CO2	Apply mathematical model to transform the geometries.	Analyze
CO3	Construct 3D CAD Models and Assemblies using concept of geometric modeling	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction** A typical product cycle, CAD tools for the design process of product cycle, CAD / CAM system evaluation criteria, Input / Output devices; Graphics Displays: Refresh display, DVST, Raster display, pixel value and lookup table, estimation of graphical memory, LCD, LED fundamentals. Concept of Coordinate Systems: Working Coordinate System, Model Coordinate System, Screen Coordinate System. Line and Curve generation algorithm: DDA, Bresenham's algorithms. Graphics exchange standards and Database management systems.	6
II	**Curves and surfaces** Parametric representation of lines: Locating a point on a line, parallel lines, perpendicular lines, distance of a point, Intersection of lines. Parametric representation of circle, Ellipse, parabola and hyperbola. Synthetic Curves: Concept of continuity, Cubic Spline: equation, properties and blending. Bezier Curve: equations, properties; Properties and advantages of B-Splines and NURBS. Various types of surfaces along with their typical applications.	6
III	**Geometric Modeling and Analysis** Geometry and Topology, Comparison of wireframe, surface and solid models, Properties of solid model, properties of representation schemes, Concept of Half-spaces, Boolean operations. Schemes: B-rep, CSG, Sweep representation, ASM, Primitive instancing, Cell Decomposition and Octree encoding..	8
IV	**Geometry Transformation** Homogeneous representation; Translation, Scaling, Reflection, Rotation, Shearing in 2D and 3D; Orthographic and perspective projections. Window to View-port transformation.	6

V	**Finite Element Analysis** Review of stress-strain relation and generalized Hooke's Law, Plane stress and Plane strain conditions; Concept of Total Potential Energy; Basic procedure for solving a problem using Finite Element Analysis.	6
VI	**Computer Aplication in Design** Collaborative Design, Principles, Approaches, Tools, Design Systems. Product Data Management (PDM), concurrent engineering, PLM concept.	7

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Explain the CAD and its advantages and disadvantages.
2. Explain types of curves and its applications in surface modeling.
3. Summarise geometric modeling techniques.
4. Perform the different transformations using mathematical / matrix relations.
5. Apply tolerancing and mathematical models.
6. Handle product data enchange format in CAD/Computer based system.

Text Books	
1	P N Rao, "CAD/CAM: Principles and Applications", Mc Graw Hill Education, Third Edition, 2010.
2	Mikell P. Groover, Emory W. Zimmers, "CAD/CAM: Computer-Aided Design and Manufacturing", Prentice-Hall, 1984.

References	
1	Ibrahim Zeid, " Mastering CAD/CAM", Tata McGraw Hill Education Pvt Ltd., New Delhi, Special Indian Edition, 2007, Ninth Reprint 2010.
2	Ibrahim Zeid, R. Sivasubramanian, "CAD/CAM: Theory and Practice", Tata McGraw Hill Companies, Special Indian Edition, 2009.

Useful Links	
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CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VII
Course Code	
Course Name	Non-Conventional Machining
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To learn about various nonconventional machining processes with 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.
4	To motivate the students to pursue advanced studies, research and industrial product development in the field of mechanical engineering.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain various nonconventional machining processes, tooling and equipment's required for various manufacturing applications.	Apply
CO2	Exploit the capabilities and applications of nonconventional machining processes.	Analyze
CO3	Analyze effect of different parameters influencing on nonconventional machining processes and compare with other technique applications.	Evaluate

Module	**Module Contents**	**Hours**
I	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	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	7
III	Electric Discharge Machining (EDM)- working Principle-equipment's-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications-Micro-EDM, Micro-WEDM.	6
IV	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	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	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), Selective Laser Sintering (SLS), Three-dimensional printing, Laminated Object Modeling (LOM). Rapid manufacturing and Rapid tooling.	7

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Describe the nonconventional machining processes, machining aspects, and their importance.
2. Explain various mechanical energy based processes, main variables, equipment's and applications.
3. Figure out capabilities of electrical energy based processes their working principle, tooling's and applications.
4. Discuss types of chemical machining processes their equipment's, different techniques and process parameters with applications.
5. Explore the laser beam machining different techniques, process characteristics, equipment and applications.
6. Articulate the different additive manufacturing techniques, their principles and applications.

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, 2007.

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, 1989.

Useful Links	
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CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course				
Bloom's Taxonomy Level	**T1**	**T2**	**ESE**	**Total**

1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

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 and 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,

CO1	Apply knowledge of mathematics, science, and engineering for the needs in refrigeration, air conditioning and cryogenic	Apply
CO2	Analyze different refrigeration, air conditioning and cryogenic systems with their applications.	Analyze
CO3	Evaluate refrigeration and air-conditioning systems under different conditions.	Evaluate

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).	7
II	**Multi pressure System and Refrigerants:** Multi pressure System: Removal of flash gas, Flash inter-cooling, Water-cooling, Multistage, Multi-evaporator and Cascade System. Refrigerants: Classification, Desirable Properties like Thermodynamic, physical and chemical. Comparison among commonly used refrigerants, Selection of Refrigerants, Effect on Ozone depletion and global warming, Alternative Refrigerants. Secondary refrigerants.	6
III	**Cryogenics and Vapor Absorption System** Cryogenics:	7

	Introduction to cryogenic engineering and application, liquefiers 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).	
IV	**Refrigeration Equipments:** Types of Compressor, Condenser, Evaporator, Expansion devices, and selection, use of insulation, its types and applications..	6
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.	7
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.	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Describe and recall basics of thermodynamics and study and analyze VCC.
2. Carry out performance study of multistage VCC. Classify the refrigerants; explain the physical, chemical properties of refrigerants.
3. Study the applications and cryogenic systems. Analyze vapor absorption system.
4. Select different equipment used in refrigeration and become familiar with application of refrigeration.
5. Describe and recall basics of thermodynamics and air conditioning.
6. Calculate heating and cooling load for air conditioning systems.

Text Books	
1	C. P. Arora ,"Refrigeration and Air conditioning", Tata McGraw Hill Education Private Limited , third edition,2008
2	Roy J. Dossat "Principles of Refrigeration", Pearson, fourth edition, 2020

References	
1	Wilbert F. Stoecker, Industrial refrigeration handbook, 1st edn., McGraw-Hill Professional Publishing,1998
2	Wilbert F. Stoecker, Jerold W. Jones, "Refrigeration and Air Conditioning", McGraw-Hill Publishing , 2nd ed. ,2008
3	Shan K. Wang, "Handbook of air conditioning and refrigeration" McGraw-Hill international edition, second edition.

Useful Links	
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CO-PO Mapping

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

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

Assessment (for Theory Course)
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B.Tech., Sem VII
Course Code	
Course Name	Computer Aided Design (CAD) Lab
Desired Requisites:	

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

Course Objectives

1	To familiarize the student with different modeling techniues used for component design.
2	To develop the students to use mathematical representation of geometries and different tolerance techniques.
3	To make students aware of use of computer for data exchange formats and tools.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain different modeling techniques and optimization technique.	Understand
CO2	Apply drafting techniques to generate different views of components.	Apply
CO3	Construct 3D CAD Models and Assemblies using concept of geometric modeling	Analyz

List of Experiments / Lab Activities

List of Experiments:

1. Explain different modeling techniques. (4 Hrs)
2. Create simple 3D component. (2 Hrs)
3. Create complicated 2D and 3D components. (4 Hrs)
4. Make any two assemblies of minimum 5 components. (4 Hrs)
5. Make any two assemblies of minimum 10 components. (4 Hrs)
6. Create drafted view of assembly and parts. (2 Hrs)
7. Use of FEA technique for optimization of design. (6 Hrs)

Text Books

1	P N Rao, "CAD/CAM: Principles and Applications", Mc Graw Hill Education, Third Edition, 2010.
2	Mikell P. Groover, Emory W. Zimmers, "CAD/CAM: Computer-Aided Design and Manufacturing", Prentice-Hall, 1984.

References

1	Ibrahim Zeid, " Mastering CAD/CAM", Tata McGraw Hill Education Pvt Ltd., New Delhi, Special Indian Edition, 2007, Ninth Reprint 2010.
2	Ibrahim Zeid, R. Sivasubramanian, "CAD/CAM: Theory and Practice", Tata McGraw Hill Companies, Special Indian Edition, 2009.

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

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	10	10	15	**35**
Apply	10	10	15	**35**
Analyze	10	10	10	**30**
Evaluate				
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B.Tech., Sem VII
Course Code	
Course Name	Non-Conventional Machining Lab
Desired Requisites:	

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

Course Objectives

1	To make students familiar with different non-conventional machining techniques.
2	To provide a hands on experience with different non-conventional machining setups.
3	To impart practical knowledge about various parameters and their effect on machining materials.
4	To provide exposure to different tooling's and machining capabilities.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Classify different types of non conventional machining techniques and their capabilities.	Applying
CO2	Study the effects of various process parameters on the properties of different materials in non conventional techniques.	Analyzing
CO3	Discuss the toolings and equipments required for machinng of different materials by non conventional techniques.	Evaluating

List of Experiments / Lab Activities

List of Experiments:

List of Experiments on Non-Conventional Machining: (Each Experiment of 2 hrs)

1. Introduction to the different nonconventional machining setups.
2. Hands on experiment on Abrasive Jet Machining.
3. Hands on experiments on Electric Discharge Machine (EDM)
4. Experiment on Micro-EDM.
5. Experiment on Micro-WEDM.
6. Hands on experiment on photo chemical machining techniques.
7. Machining / deposition of metals using fiber laser machine.
8. Study and demonstration of fused deposition modeling.
9. Industrial visit and report writting.

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, 2007.
4	Pandey P.C. and Shan H.S. "Modern Machining Processes", Tata McGraw – Hill, New Delhi (2007).

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,1989.
Useful Links	
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CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		3	3										2		
CO2				2								3	2	2	
CO3			2	3				3					2	2	
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand				
Apply	10	10	15	**35**
Analyze	10	10	15	**35**
Evaluate	10	10	10	**30**
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

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

Course Objectives

1	To enable the students to perform the experiment and analyze results based on principles of mathematics, science and engineering.
2	To prepare students to use modern tools and 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,

CO1	Perform the experiments in refrigeration and air conditioning as per given objectives.	Applying
CO2	Analyze different refrigeration, air conditioning and cryogenic systems with their applications.	Analyzing
CO3	Measure the performance of different systems under different conditions	Evaluating

List of Experiments / Lab Activities

List of 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 (any six)

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 and 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/trial on 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.

Text Books

1	C. P. Arora ,"Refrigeration and Air conditioning", Tata McGraw Hill Education Private Limited , third edition,
2	Roy J. Dossat "Principles of Refrigeration", Pearson, fourth edition, 2020.
References	
1	Wilbert F. Stoecker, Industrial refrigeration handbook, 1st edn., McGraw-Hill Professional Publishing,1998Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., "Fundamentals of Thermodynamics", John Wiley and Sons, 7th Edition, 2009
2	Wilbert F. Stoecker, Jerold W. Jones, "Refrigeration and Air Conditioning", McGraw-Hill Publishing , 2nd ed. ,2008
3	Shan K. Wang, "Handbook of air conditioning and refrigeration" McGraw-Hill international edition, second edition
Useful Links	
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CO-PO Mapping															
	Programme Outcomes (PO)												**PSO**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
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															

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand				
Apply	10	10	15	**35**
Analyze	10	10	15	**35**
Evaluate	10	10	10	**30**
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To learn about the nomenclature of Aerospace engineering and aircraft components.
2	To learn about basics of fluid mechanics and aerodynamics.
3	To learn about aero propulsion systems and thermodynamic cycles.
4	To understand about the performance parameters, aircraft stability and control
5	To learn about the launch vehicles and basics of satellite.
6	To understand airports and aircraft management.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Remember basics and recent trends in aerospace engineering, propulsion systems.	Apply
CO2	Apply basic physics in understanding principles of vehicle.	Analyze
CO3	Explain different performance, stability and control and launch vehicles.	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction** History of Aerospace, Atmosphere and its properties, Classification of Aerospace vehicles, basic components of aircrafts and spacecraft, vehicle control surfaces and systems, introduction to Indian Aerospace sector, major Aerospace industry and manufacturers, aerospace material technology.	7
II	**Flight Principle** Fluid mechanics: Streamlines + Steady flow + Incompressible flow, Bernoulli's Equation + Coanda Effect + Mach No, Significance of speed of sound, standard atmosphere, Aerodynamic: Aerodynamic forces acting on aircrafts and spacecraft, aerofoil nomenclature, pressure and velocity distribution, aerodynamic forces, generation of lift and drag, supersonic effects, aerodynamic center, center of pressure, aspect ratio	9
III	**Propulsion System** Propulsion systems, classifications of propulsion system, location and principle of operation. Basic principle of aircraft and spacecraft thrust production, Brayton cycle and Humphrey cycle, jet engines, propeller engines, rocket engines	7
IV	**Aircraft Performance, Stability and control** Performance: power curves, maximum and minimum speed of aircraft during steady state, effects of altitude on engine performance, escape velocity. Stability and control :Static and Dynamic stability, Steady level flight, longitudinal, lateral and directional stability, Ceilings, Steady Climbing Flight, Sustained Level Turn effects of secondary control surfaces, manoeuvres.	8
V	**Launch vehicles and Satellites**	

	Rockets and satellite materials, launch vehicle dynamics, basic orbital mechanics, satellite applications and orbits, future challenges in aerospace engineering.	5
VI	**Steam Turbines** NVH and crashworthiness of vehicles, Emission norms and control, automotive electronics, Automotive manufacturing and assembly, material and vendor management, Testing and certification of vehicles Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, Application of Fuel Cells	4

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Remember the current trends of Aerospace engineering
2. Understand and explain different types of propulsion systems
3. Apply the fluid mechanics concepts to understand the Aerodynamics
4. Understand the working of aerospace vehicle and satellite
5. Understand the application of aircraft and aerospace vehicles

Text Books	
1	John D Anderson, "Introduction to flight", McGraw-Hill Publishing Co., 2017.
2	Turner, M. J. L., "Rocket and Spacecraft Propulsion: Principle, Practice and New-Develop-ments", 3rd Edition, Springer (2016).

References	
1	Sutton G. P., "Rocket Propulsion Elements", John Wiley, New York, 8th Ed., 2011.
2	Anderson, D. F. and Eberhardt, S., "Understanding Flight, 2nd Ed. McGraw Hill (2009).

Useful Links	
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CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To understand the construction and working principle of various parts and systems of an automobile
2	To perform basic calculations required for vehicle performance and for some of important systems such as Transmission (Gear Ratios), steering system, and brake system.
3	To make student aware of latest trends in transportation towards a safe, pollution free and fully automatic vehicle.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Understand various types of Engine & Automotive systems	Apply
CO2	Analyze vehicle performance related to engine, brake and steering systems.	Analyze
CO3	Select proper engine, gear ratios, and other systems for given vehicle application with reference to safety and pollution norms.	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction, classification and Automotive power plants** Introduction, Broad classification of Engines, Basic components of Engine, Performance of Engine. 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. New engine technologies i.e turbo chargers (WGT, VGT), engine emission Control by 3-way catalytic converter system, Emission norms (Euro & BS).	6
II	**Vehicle Performance** Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Grade ability 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	**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.	7
IV	**Suspension, Steering System, Braking & Electrical systems** Suspension requirements, Sprung and Un sprung mass, Types of automotive suspension systems. Conventional and Independent, Shock absorber, Types of	7

	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,	
V	**Braking and Electrical System** 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, Dash board gauges, Wiper & side indicator circuit, Engine electronic control modules, Safety devices. braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control..	7
VI	**Recent trends in Automotive Development** NVH and crashworthiness of vehicles, Emission norms and control, automotive electronics, Automotive manufacturing and assembly, material and vendor management, Testing and certification of vehicles Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, Application of Fuel Cells	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. To select proper engine for given vehicular application
2. To analyze vehicle performance
3. To understand various types of transmission systems
4. To relate concepts of vehicle dynamics with daily experiences
5. To calculate braking performance of the vehicle in different conditions
6. To comprehend recent trends in automobile development

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	Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.

References	
1	P. W. Kett ., Motor Vehicle Science Part 2 , Chapman and Hall, 1st Edition, 1982
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

Useful Links	
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CO-PO Mapping

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

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

Assessment (for Theory Course)
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**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.
4	To understand the basics of product design and the role of industrial automation

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Identify different types automation, technological and economic issues involved in automatic manufacturing of products	Apply
CO2	Classify the major components used in automation such as commonly used sensors and analyze common techniques for sensor interfacing and protection circuits	Analyze
CO3	Interpret basic concepts of sensors and transducers into real world applications.	Evaluate

Module	**Module Contents**	**Hours**
I	Introduction: Reason of automation, Current trends, classification and types of automation, Application of automation, Goals of automation, Social issues of automation, Low cost automation, Current emphases in automation, Reasons for automation, Issues for automation in factory operation, Ten strategies for automation	6
II	Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing.	7
III	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.	6
IV	Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies.	7
V	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	Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Become familiar with the different types automations involved in manufacturing of products.
2. Use various machine tools and machining centers.
3. Get a comprehensive picture of computer based automation of manufacturing operations.
4. Utilize Hydraulic and Pneumatic system in Automation.
5. Understand the major components like sensors, their interfacing and protection circuits.
6. Implement automation knowledge in real world problems

	Text Books
1	M. P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing" Pearson Education, 2016.
2	Andrew Parr, (HB), "Hydraulic and Pneumatics ", Jaico Publishing House, 1999.
3	Industrial automation and robotics by A. K. Gupta & S. K. Sharma, Laxmi publication, 2013
	References
1	Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House, 2013.
2	Hydraulic Control Systems, Herbert E. Merritt, Wiley, 1991.
3	Electric Motor Drives, Modelling, Analysis and Control, R. Krishnan, Prentice Hall India, 2002.
	Useful Links
1	NPTEL and MOOC links

CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

	Bloom's Taxonomy Level	T1	T2	ESE	Total
1	Remember				
2	Understand	7	8	20	**35**
3	Apply	8	7	17	**32**
4	Analyze	5	5	23	**33**
5	Evaluate				
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	16 Hrs/Week	-			
Interaction	-	**Credits: 8**			

Course Objectives

1	To help students to address real life challenges and discuss project requirements.
2	To give technical solutions through latest design & development tools.
3	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.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Understand the importance of teamwork and will be able to work in a team for achieving group goals / will be prepared to assume a leadership role in any team.	Understand
CO2	Analyze and give solutions for a specific problem statement related to their project.	Analyse
CO3	Prepare and present a detailed report based on project work spread over two semesters.	Creating

List of Experiments / Lab Activities

Course Contents:

i) Completion of manufacturing / processing-assembly / testing work of the project by end of the semester.

ii) Testing, result analysis etc.

iii) Rectifications/ correction if required.

iv) Final report presentation.

Text Books

1.	Various printed and electronic resources available on the internet and institute library.

References

1.	All types of standard journals, conference proceedings etc.

Useful Links

1	Online resources in the selected domain areas.

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

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand	10	5	10	**25**
Apply				
Analyze	10	10	10	**30**
Evaluate				
Create	10	15	20	**45**
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B.Tech., Sem VIII
Course Code	
Course Name	Skill Based Learning
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	2Hrs/Week	-			
Interaction	-	**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 common 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,

CO1	Prepare for Co Curricular and Extracurricular activities (Technical/Non. Tech/Social etc.)	Apply
CO2	Develop the ability for working in a diversified team.	Analyze
CO3	Judge his/her ability in various events.	Evaluate

List of Experiments / Lab Activities

Text Books

NA

References

NA

Useful Links

1	
2	

CO-PO Mapping

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

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

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates the starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand				
Apply	10	10	15	**35**
Analyze	10	10	15	**35**
Evaluate	10	10	10	**30**
Create				
Total Marks	**30**	**30**	**40**	**100**

Event	Details	1st Prize	2nd Prize	3rd Prize	Participation
Technical events, Sports, Cultural, Social	National	30	25	20	15
	State	25	20	15	10
	Inter College/Dist./ City	10	08	06	04
Students club	President, Vice President, Treasurer, Secretary	10			
	Member/Volunteer	05			

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	-	-			
Interaction	1Hrs/week	**Credits: 1**			

Course Objectives

1	Following are the intended objectives of internship training: • Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry. • Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job. • Exposure to the current technological developments relevant to the subject area of training. • Experience gained from the 'Industrial Internship' in the classroom will be used in classroom discussions. • Create conditions conducive to quest for knowledge and its applicability on the job. • Learn to apply the Technical knowledge in real industrial situations. • Gain experience in writing Technical reports/projects. • Expose students to the engineer's responsibilities and ethics. • Familiarize various materials, processes, products and their applications along with relevant aspects of quality control. • Promote academic, professional and/or personal development. • Expose the students to future employers. • Understand the social, economic and administrative considerations that influence the working environment of industrial organizations • Understand the psychology of the workers and their habits, attitudes and approach to problem solving.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Notice an improvement in his/her understanding and practical skills.	Apply
CO2	Understand and value the importance of working in a diversified field.	Analyze
CO3	Demonstrate the soft skills like presentation skills, technical report writing etc.	Evaluate

Module	**Module Contents**	**Hours**

Assessments :

Internships carried out by the student will be evaluated based on overall knowledge gained from the concerned industry. This evaluation will be carried out by the concern mentor allocated to individual students by the department before LA4/ISE-2.

1. The overall assessment is for 100 marks and minimum 40 marks should be scored by student for passing

Text Books	
	Not applicable.
References	
	Not applicable.
Useful Links	
1	

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

Assessment				
There are three components of lab assessment, LA1, LA2 and Lab ESE. IMP: Lab ESE is a separate head of passing. LA1, LA2 together is treated as In-Semester Evaluation.				
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 6 Marks Submission at the end of Week 6	30
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 7 to Week 12 Marks Submission at the end of Week 12	30
Lab ESE	Lab activities, attendance, journal	Lab Course Faculty	During Week 15 to Week 18 Marks Submission at the end of Week 18	40
Week 1 indicates starting week of a semester. The typical schedule of lab assessments is shown, considering a 26-week semester. The actual schedule shall be as per academic calendar. 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.				

Assessment Plan based on Bloom's Taxonomy Level (Marks) (For lab Courses)				
Bloom's Taxonomy Level	**LA1**	**LA2**	**Lab ESE**	**Total**
Remember				
Understand				
Apply	10	10	15	**35**
Analyze	10	10	15	**35**
Evaluate	10	10	10	**30**
Create				
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**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,

CO1	Understand various phases in product lifecycle and its considerations in product development	Apply
CO2	Understanding PLM backend technologies and its implementation	Analyze
CO3	Compare functionalities of various commercial PLM systems	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction To Product Lifecycle Management** Product lifecycle – Introduction, growth, maturity & decline, Product LifecycleManagement- Definition & Overview, Background for PLM-corporate challenges,Need of PLM, Components/Elements of PLM, Emergence of PLM, Significanceof PLM - lifecycle problems to be resolved, product development problems to beresolved, Customer Involvement. Product lifecycle – Introduction, growth, maturity & decline, Product Lifecycle Management Definition & Overview, Background for PLM-corporate challenges, Need of PLM, Components/Elements of PLM, Emergence of PLM, Significance of PLM - lifecycle problems to be resolved, product development problems to be resolved, Customer Involvement.	6
II	**Constructing Product Lifecycle Management & Driving Environment** PLM Lifecycle model- plan, design, build, support & dispose. Threads of PLM computer aided design (CAD), engineering data management (EDM), Productdata management (PDM), computer integrated manufacturing (CIM). Weavingthe threads into PLM, comparison of PLM to Engineering resource planning(ERP). PLM characteristics - singularity, cohesion, traceability, reflectiveness,Information Mirroring Model. External drivers- scale, complexity, cycle times,globalization & regulation. Internal drivers - productivity, innovation,collaboration & quality. Board room drivers – income, revenues & costs..	7
III	**Digital Lifecycle** Collaborative Product Development, Mapping Requirements to specifications. Part Numbering, Engineering Vaulting, Product reuse, Engineering Change Management, Bill of Material and Process Consistency. Digital Mock up	6

	andPrototype development. Virtual testing and collateral. Introduction to Digital Manufacturing.	
IV	**Product Lifecycle Management System** Product lifecycle management system- system architecture, Informationmodels and product structure, Information model, the product information data model, the product model, functioning of the system. Reasons for thedeployment of PLM systems.	6
V	**Product Lifecycle Environment** Product Data issues – Access, applications, Archiving, Availability, Change, Confidentiality. Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM.	7
VI	**Components of Product Lifecycle Management** Different phases of product lifecycle and corresponding technologies, Foundation technologies and standards e.g. visualization, collaboration and enterprise application integration, Core functions e.g., data vaults, document and content management, workflow and program management, Functional applications e.g., configuration management. Human resources in product lifecycle. PLM Case Study.	7

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Work on any PLM tool.
2. Implement different phases of design in PLM and integrate the different elements for Product Lifecycle Management execution.
3. Identify the various requirements in product development process in consideration to digital manufacturing..
4. Compare various commercial PLM systems
5. Associate the role of database management systems in PLM
6. Evaluate the different phases of product lifecycle technologies through case studies

Text Books	
1	Antti Saaksvuori, Anselmi Immonen, Product Lifecycle Management - Springer, 1st Edition (Nov.5, 2003)
2	Stark John, Product Lifecycle Management - 21st Century Paradigm for Product Realization, Springer, 2005.
3	Hoffer J, Prescott M, McFadden F, Modern Database Management, Prentice Hall, 2007.

References	
1	Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006. ISBN 0071452303
2	Stark, John. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer-Verlag, 2004. ISBN 1852338105.
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	
2	

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

CO1	3		1		2							1	2	2	
CO2		3	2		2							1	2	2	
CO3		3	2	2	2	1	1					2	1	3	
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High															

Assessment (for Theory Course)
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To expose the student to the various fundamentals of robotics systems.
2	To make the students familiar with criteria for implementing robotic systems.
3	To explain students about Robotics and its allied interdisciplinary approach, component design and sensor technology.
4	To evolve prominent component of Automated Manufacturing Systems and controllers to perform a Programmed tasks.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Determine the fundamental concepts of Automation and Robotics	Apply
CO2	Choose sensors, actuators and motion conversion devices	Analyze
CO3	Defend the working of Robot software/ hardware	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction, Actuators and Drive Systems** Creation of Robotics, Manipulation and Dexterity, Locomotion and Navigation, DC Motor, Dynamics of single axis drive system, Power Electronics, Pulse width modulation (PWM), PWM switching characteristics, The H-bridge and bipolar PWM amplifiers, Robot Controls and PWM Amplifiers, Optical Shaft Encoders, Brushless DC Motors.	7
II	**Robot Mechanisms** Joint Primitives and Serial Linkages, Parallel Linkages, Planar Kinematics of Serial Link Mechanisms, Inverse Kinematics of Planar Mechanisms, Kinematics of Parallel Link Mechanisms, Redundant mechanisms.	6
III	**Differential Motion** Differential Relationship, Properties of the Jacobian, Inverse Kinematics of Differential Motion, Singularity and Redundancy	6
IV	**Statics** Free Body Diagram, Energy Method and Equivalent Joint Torques, Duality of Differential Kinematics and Statics, Closed-Loop Kinematic Chains, Over-Actuated Systems, Newton-Euler Formulation of Equations of Motion.	7
V	**Dynamics** Basic Dynamic Equations, Closed-Form Dynamic Equations, Physical Interpretation of the Dynamic Equations, Lagrangian Formulation of Robot Dynamics, Lagrangian Dynamics, Planar Robot Dynamics, Inertia Matrix, Generalized Forces.	7
VI	**Force and Compliance Controls**	

	Hybrid Position/Force Control, Principle, Architecture, Compliance Control, Task strategy, Compliance control synthesis.	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. 1. Explain advanced manufacturing systems
2. 2. Introduce the idea of implementation of robotics
3. 3. Use of robot in CIM environment
4. 4. Apply the fundamentals of robotics on real life problems.
5. 5. Observe anatomy parameters of robot
6. 6. Describe new trends in robotics

Text Books	
1	Antti Saaksvuori, Anselmi Immonen, Product Lifecycle Management - Springer, 1st Edition (Nov.5, 2003)
2	Stark John, Product Lifecycle Management - 21st Century Paradigm for Product Realization, Springer, 2005.
3	Hoffer J, Prescott M, McFadden F, Modern Database Management, Prentice Hall, 2007.

References	
1	Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006. ISBN 0071452303
2	Stark, John. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer-Verlag, 2004. ISBN 1852338105.
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	
2	

CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To make the students to understand principles and elements of total quality management.
2	To prepare the students for the analysis and use of various total quality management tools.
3	To prepare the students to analyze implementation of modern quality tools.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Understand quality management philosophies and frameworks	Apply
CO2	Apply the knowledge on various tools and techniques of quality management	Analyze
CO3	Analyze the implementation of quality tools and techniques in both manufacturing and service industry	Evaluate

Module	**Module Contents**	**Hours**
I	Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; costs to quality	6
II	TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection	7
III	The seven traditional tools of quality; New management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types.	7
IV	TQM tools and techniques, control charts, process capability, Quality Function Development (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 in manufacturing and service sectors, case studies of TQM implementation	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Understand basic concepts of TQM and contributions of quality Gurus.

2. Elaborate TQM principles such as employee involvement and empowerment, quality circles, KAIZEN, etc.
3. Compare traditional and new management tools, concepts of Six Sigma and FMEA.
4. Explain the basic concepts and applications QFD and Six Sigma technique.
5. Identify the principles, requirements and implementation of ISO quality systems.
6. Analyze TQM implementation in manufacturing and service industry.

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

References	
1	Juran J.M. and Gryna F.M. , Quality Planning and Analysis, McGraw-Hill Education
2	Bedi Kanishka., Quality Management, Oxford University Press, 2006
3	Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

Useful Links	
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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	3				2				
CO2	2	2				3		3				2			
CO3		3		1		2			3					2	

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		T1	T2	ESE	Total
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To understand the construction and working principle of various parts and systems of an automobile
2	To perform basic calculations required for vehicle performance and for some of important systems such as Transmission (Gear Ratios), steering system, and brake system.
3	To make student aware of latest trends in transportation towards a safe, pollution free and fully automatic vehicle.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Understand various types of Engine & Automotive systems	Apply
CO2	Analyze vehicle performance related to engine, brake and steering systems.	Analyze
CO3	Select proper engine, gear ratios, and other systems for given vehicle application with reference to safety and pollution norms.	Evaluate

Module	**Module Contents**	**Hours**
I	**Introduction, classification and Automotive power plants** Introduction, Broad classification of Engines, Basic components of Engine, Performance of Engine. 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. New engine technologies i.e turbo chargers (WGT, VGT), engine emission Control by 3-way catalytic converter system, Emission norms (Euro & BS).	6
II	**Vehicle Performance** Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Grade ability 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	**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.	7
IV	**Suspension, Steering System, Braking & Electrical systems** Suspension requirements, Sprung and Un sprung mass, Types of automotive suspension systems. Conventional and Independent, Shock absorber, Types of	7

	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,	
V	**Braking and Electrical System** 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, Dash board gauges, Wiper & side indicator circuit, Engine electronic control modules, Safety devices. braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control..	7
VI	**Recent trends in Automotive Development** NVH and crashworthiness of vehicles, Emission norms and control, automotive electronics, Automotive manufacturing and assembly, material and vendor management, Testing and certification of vehicles Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles, Application of Fuel Cells	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. To select proper engine for given vehicular application
2. To analyze vehicle performance
3. To understand various types of transmission systems
4. To relate concepts of vehicle dynamics with daily experiences
5. To calculate braking performance of the vehicle in different conditions
6. To comprehend recent trends in automobile development

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	Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi, 2002.

References	
1	P. W. Kett ., Motor Vehicle Science Part 2 , Chapman and Hall, 1st Edition, 1982
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

Useful Links	
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CO-PO Mapping

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

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

Assessment (for Theory Course)
The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course					
Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**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,

CO1	Explain the theory of pressure vessels and gear box design.	Apply
CO2	Use Johnson's method of optimum design to design mechanical components.	Analyze
CO3	Estimate the tolerances and reliability of mechanical components and systems.	Evaluate

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	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.	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	System Approach to Design; Mathematical model; Lumped system; Dynamic response of lumped & distributed system; Modeling of masses, Elasticity, Inertia, Damping and friction.	6

VI	Identification of 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

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Use Johnson's method of optimum design to design mechanical components.
2. Estmate the tolerances and reliability of mechanical components and systems.
3. Discuss the theory of gear box design.
4. Explain the theory of pressure vessels design.
5. Demonstrate the approach in system design
6. Design the products as per the needs of society considering aesthetics and ergonomics concept

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

References	
1	M.V.Joshi, " Process Equipment Design" , Macmillal Publication, 1976
2	Robert L.Norton , "Machine Design", Tata Mc- Graw Hill Publication, 2001
3	Anurag Dixit , "Mechanical System Design" , SCITECH publication, 2005
4	Black P.H.and O.Eugene Adams , "Machine Design", Tata Mc- Graw Hill Publication, 3rd Edition, 1993

Useful Links	
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CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				

Total	**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

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

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To gain knowledge on the principles and procedure for the design of Mechanical power transmission components.
2	To train students in the standard procedure available for design of transmission systems of machines.
3	To provide the students with knowledge of gear design.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain the theory of power transmission and gear box design.	Apply
CO2	Use the given data tables to arrive at proper specifications of flexible power transmission element.	Analyze
CO3	Design the gear box as per the need of functioning of machine.	Evaluate

Module	**Module Contents**	**Hours**
I	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	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	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	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	8
V	Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses	5
VI	Design of plate clutches, axial clutches, cone clutches, internal expanding rim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes,	6

	internal expanding shoe brake.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Select the proper belt for the given application.
2. To design spur and helical gears to suit the system requirement.
3. To design worm and bevel gears as per system requirement.
4. Discuss the theory of gear box design.
5. Estimate the profile of cam based on the requirement.
6. Design the products as per the needs of society considering aesthetics and ergonomics concept.

Text Books	
1	Bhandari V, Design of Machine Elements, 3rd Edition, Tata McGraw-Hill Book Co, 2010.
2	Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
3	N. K. Mehta, Machine Tool Design and Numerical Control, 3rd ed., Tata McGraw Hill, 2012.

References	
1	R. L. Norton, Design of Machinery, McGraw Hill Publication, 3rd Edition, 2003
2	Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
3	Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001.
4	PSG Design Data Book

Useful Links	
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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	2	
CO2			3					2					2	2	
CO3			3	2									3	2	

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom's Taxonomy Level (Marks) For Theory Course

Bloom's Taxonomy Level		**T1**	**T2**	**ESE**	**Total**
1	Remember				
2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	B.Tech. (Mechanical Engineering)
Class, Semester	Final Year B. Tech., Sem VIII
Course Code	
Course Name	Experimental Stress Analysis
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	3Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-	-			
Interaction	-	**Credits: 3**			

Course Objectives

1	To provide a basic knowledge of techniques in experimental stress analysis.
2	To show strain gauge bridge configurations and related instrumentation to take readings.
3	To teach different polariscope arrangements along with auxiliary equipment required for photoelasicity

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain the basics of stress, strain and the various methods of measurement.	Apply
CO2	Illustrate knowledge of photo elasticity to find out isoclinic and isochromatic pattern.	Analyze
CO3	Identify various methods and instrumentation for strain measurement.	Evaluate

Module	**Module Contents**	**Hours**
I	Introduction to ESA, Advantages of ESA techniques, Necessity of various ESA methods, methodology of problem solving by ESA. Introduction of few concepts of Mechanics of materials and preferably some understanding of the theory of elasticity.	6
II	Theory of Photo Elasticity: Introduction, Optics related to photo elasticity- Ordinary light, Monochromatic light, polarized light, natural and artificial birefringence, Stress optic law in two dimensions at normal incidence, material fringe value in terms of stress function, Polariscope – Plane polariscope, Circular polariscope, Different Arrangements, Effect of stressed model in plane polariscope – Isoclinics, Isochromatics, Effect of stressed model in circular polariscope– Isochromatics, Use of white light and determination of orders of isochromatic fringes seen in the circular polariscope, Fractional fringe measurement: (i) Tardy's Method (with derivation) (ii) Babinet Soleil Method. Photoelastic Materials Criterion for selection of model materials, Properties of commonly employed photo elastic materials, Casting technique and machining of model, Conclusions pertaining to material selection, Calibration methods -circular disc, tensile specimen, beam model, Significance of material fringe value.	8
III	Determination of direction of Principal stresses at given point, Determination of exact fringe order N and the principal stress difference ($\sigma1 - \sigma2$) at the given point, Separation methods i) Method based on Hook's Law ii) Electrical analogy method iii) Oblique incidence method iv) Shear difference method, Scaling model results to prototype	6
IV	Introduction, types, construction and material, Gauge factor, cross or transverse	7

	sensitivity, correction for transverse strain effect, semiconductor strain gauge. Selection and Mountings of Strain Gauges: Grid, backing, adhesive, mounting methods, checking gauge installation, Moisture proofing. Strain Gauge\ Circuitry: Measurement of force or load, Measurement of torque, Strain measurement of rotating shaft, Measurement of pressure or vacuum.	
V	Introduction – Analysis of strain gauge data by analytical and graphical methods, Analysis when principal stress directions are known, Analysis when principal stress directions are unknown, i) Delta rosette ii) Tee-rosette iii) Four element rectangular rosette iv) Rectangular rosette – Two and three element.	7
VI	Brittle coating method - merits, demerits, applications, Moiré fringe method - merits, demerits, applications, Birefringent coating-principle and working of reflection polariscope	6

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Explain the basics of stress, strain and the various methods of measurement.
2. Apply the knowledge of photoelasicity to find out isoclinic and isochromatic pattern.
3. Interpret the various methods of fractional fringe measurement.
4. Use various methods and instrumentation for electrical resistance strain gauge.
5. Estimate the strain by various strain arrangements i.e. Delta, Tee and rectangular.
6. Demonstrate the brittle coating technique.

Text Books	
1	. James W. Dally, William Franklin Riley, “Experimental Stress Analysis”, McGraw Hill, 3rd Edition, 1991
2	Srinath, L. S., Raghava, M.R., Lingaiah K.,Gargesha G., Pant B. and Ramachandra, K., “Experimental Stress Analysis”, Tata McGraw Hill, New Delhi, 1984

References	
1	Dr. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publications, 6th Edition, 2009
2	Richard C. Dove, Paul H. Adams , “Experimental Stress Analysis and Motion Measurement”, Merrill Books Publisher; 1st Edition,1964

Useful Links	
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2	

CO-PO Mapping

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

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

Assessment (for Theory Course)

The assessment is based on 2 in-semester examinations in the form of T1 (Test-1) and T2 (Test-2) of 20 marks each. Also there shall be 1 End-Sem examination (ESE) of 60 marks. T1 shall be typically on modules 1 and 2, T2 based typically on modules 3, 4 and ESE shall be on all modules with nearly 50% weightage on modules 1 to 4 and 50% weightage on modules 5, 6.

Assessment Plan based on Bloom’s Taxonomy Level (Marks) For Theory Course

Bloom’s Taxonomy Level		T1	T2	ESE	Total
1	Remember				

2	Understand				
3	Apply	7	8	20	**35**
4	Analyze	8	7	17	**32**
5	Evaluate	5	5	23	**33**
6	Create				
Total		**20**	**20**	**60**	**100**