Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE601
Course Name	Legal, Financial Aspects of Industrial Project
Desired Requisites:	

Teaching Scheme (hrs/week)		**Examination Scheme (Marks)**			
Lecture	2	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 2**			

Course Objectives

1	To provide the understanding of taxation, profitability and economic decision making.
2	To make students financially literate so as to undertake the industrial projects.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Select and use different financial models in effectively executing industrial projects.	Evaluate
CO2	Perform the risk and cost assessment of an industrial project.	Analyse
CO3	Understand environment and labour laws which regulate the industry.	Understand

Module	**Module Contents**	**Hours**
I	**Economic Decision Making** Introduction, Mathematics of Time Value of Money: Compound Interest, Cash Flow Diagram, Uniform Annual Series, Irregular Cash Flows, Cost Comparison: Present Worth Analysis, Annual Cost Analysis, Capitalized Cost Analysis	4
II	**Taxes and Profitability** Taxes, Profitability Of Investments: Rate of Return, Payback Period, Net Present Worth, Internal Rate of Return, Inflation, Sensitivity and Break-Even Analysis, Uncertainty in Economic Analysis	4
III	**Factories Act, 1948:** Health, Safety, Provisions relating to Hazardous Processes, Welfare, Working Hours of Adults, Employment of young persons, Annual Leave with wages. The Employees Provident Fund and Miscellaneous Provisions Act, 1952.	4
IV	**Constitution and Labour Laws:** Labour laws, Equality before law and its application in Labour Laws, Equal pay for equal work; and Article-16 and reservation policies, Articles 19, 21, 23 and 24 and its implications.	4
V	**Risk Assessment and Safety** Regulation as a Result of Risk, Standards, Risk Assessment, Probabilistic Approach to Design, Safety Factor, Worst-Case Design, Design for Safety, Guidelines for Design for Safety	4
VI	**Cost Evaluation** Introduction, Categories of Costs, Overhead Cost, Activity-Based Costing, Methods of Developing Cost Estimates, Parametric and Factor Methods,	4

	Detailed Methods Costing, Make-Buy Decision, Product Profit Model, Profit Improvement, Case studies related design project	
Text Books		
1	P.L. Mehta, Managerial Economics Analysis, Problems and cases, S. Chand & Co. Ltd., 2001	
2	Dieter G.E., Engineering Design, McGraw-Hill Education 5th edition, 2012.	
3	N. Godbole, S. Belapure, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt. Ltd.	
References		
1	Peterson and Lewis: Managerial Economics, 4th Ed., Prentice Hall, 2004	
2	R. Drefuss, J. Pila; The Oxford Handbook of Intellectual Property Law, Oxford University Press, 2018.	
3	Adv. P. Mali, Cyber Law & Cyber Crimes Simplified, Cyber Infomedia, 2017.	
Useful Links		
1	https://www.youtube.com/watch?v=qxulgasY3ns	
2	https://iclg.com/practice-areas/employment-and-labour-laws-and-regulations/india	
3	https://nptel.ac.in/courses/110/107/110107144/	

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

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 be1 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	5	5	20	30
3	Apply				
4	Analyze	5	5	20	30
5	Evaluate	10	10	20	40
6	Create				
Total		**20**	**20**	**60**	**100**

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AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE690
Course Name	Dissertation Phase I
Desired Requisites:	Concept knowledge of research methodology, project management, mechanical engineering

Teaching Scheme (Hrs)		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	20				
Interaction	-	**Credits: 10**			

Course Objectives	
1	To develop the student to apply the knowledge gained to identify problems for research and provide the solutions by self-study and interaction with stakeholders.
2	Acquire knowledge to tackle real world problems of societal concerns
3	Impart flexibility to the student to have increased control over his/ her learning
4	Teachers would serve as mentor/facilitator of inquiry and reflection rather than as an instructor
5	Enhance a students' learning through increased interaction with peers and colleagues.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Search the existing literature and identification of research problem	Analyze
CO2	Design and develop the solution for complex engineering problem	Evaluate
CO3	Create the new knowledge in the specialized field	Create

Course Content

Students are expected to carry out independent research work on the chosen topic. In this semester it is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of initial results thus obtained. In fourth semester, the students continue their dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as proposed in the synopsis. The work should be completed in all respects this semester. The students are required to submit the dissertation work in the form of report as per the institute rule.

Text Books	
1	As per the research topic

References	
1	National and International Journals

Useful Links	
1	https://nptel.ac.in/courses/121/106/121106007/
2	https://www.youtube.com/watch?v=mAVswCbz_jM&feature=emb_imp_woyt

3	https://nptel.ac.in/courses/110/104/110104073/
4	https://nptel.ac.in/courses/110/107/110107081/

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

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				
Analyze	10	10	10	**30**
Evaluate	10	10	10	**30**
Create	10	10	20	**40**
Total Marks	**30**	**30**	**40**	**100**

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AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE602
Course Name	Industry Orientation Course
Desired Requisites:	

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

Course Objectives	
1	To provide a hands on experience of software in solving complex mechanical engineering problems.
2	To enhance the employability of mechanical design engineering student.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Use of the software related to design of mechanical system effectively.	Evaluate
CO2	Develop the solution for mechanical engineering problem using software.	Create
CO3	Explain the working of research and development department.	Understand

Course Content

This course is based on computers as a tool to design and analyse the mechanical system. In the modern day work environment, the Mechanical Design Engineer should be able to simulate and solve complex problems on computers. The Mechanical Design Engineer must be highly computer literate. The engineer with strong fundamentals in Design Engineering and computer software proficiency is highly in demand from industry. Employability of the student can be enhanced by providing software training of Analysis and simulation software in mechanical engineering.

Text Books	
1	Suitable books based on the software selected.

References	
1	Suitable books based on the contents of software selected

Useful Links	
1	As per the need of the software training

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

Each CO of the course must map to at least one PO.

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

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Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE611
Course Name	Advanced Finite Element Method
Desired Requisites:	

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 2**			

Course Objectives	
1	Student will be able to develop his own FE formulation for static problems.
2	Student will be able to decide the best suited method for transient analysis.
3	Student will be able to appreciate the amount of computational efforts required to solve non Linear problem.
4	Student will understand mathematical modelling technique for beams and plate.
5	Student will be able to apply various beam and plate theories to develop FE model. Through course project student will apply his understanding of FE in his/ her own field

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Solve non-linear problems using FEM.	Apply
CO2	Analyse structural analysis using beam, plate and shell elements	Analyse
CO3	Evaluate the given design problem using FEM	Evaluate

Module	**Module Contents**	**Hours**
I	**Linear static analysis :** Weighted residual formulation, shape functions, numerical integrations.	4
II	**Solution methods to solve linear transient problems:** Explicit and implicit methods, Newmark family of methods, conditional and unconditionally stable methods and determination of correct time step.	4
III	**Non-linear finite Element Method:** Ways of non-linearities, mathematical treatment, Picard's method, Newton's method, advantages and limitations of each method, snap through problem.	5
IV	**Analysis of beams:** Euler Bernoulli beam theory, Timoshenko beam theory, Formulation of beam element using both above theories, their advantages and limitations, solution strategies to overcome limitations.	5
V	**Analysis of plates and shells:** Basics of plate theory, thin and thick plates, FE formulation based on various plate theories, plate elements, continuity requirements.	4
VI	**Course Project – self learning**: The student is expected to define his/ her own problem which involves substantial Complications in terms of geometry, boundary conditions etc. in any field and then try to solve the same either by developing own code or using commercially available software's. Difficulties will be discussed in class in common or individually.	4

Text Books	
1	Cook, R. D., Malkus D. D. and PleshaM. E., "Concepts and Applications of Finite Element Analysis", 4th edition, 2001.
2	Bathe, K. J., "Finite Element Procedures",1st edition,2008
3	Hughes, T. J. R., "The Finite Element Method – Linear Static and Dynamic Finite Element Analysis", 2012.
References	
1	Belytschko, T., Liu, W. K. and Moran, B., "Nonlinear Finite Elements for Continua and Structures".
2	Brebbia C. A. and Dominguez J. "Boundary Elements an Introductory Course", freely available at http://www.boundaryelements.com/
Useful Links	
1	https://www.youtube.com/watch?v=MldJ6WHCsvQ
2	https://www.youtube.com/watch?v=cHiFQ-cESkg
3	https://www.youtube.com/watch?v=URbiADhc_rA&list=PLD53819B88894AEDF
4	https://www.youtube.com/watch?v=pCSpBYfbYYA

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

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 be1 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	5	5	20	30
4	Analyze	5	5	20	30
5	Evaluate	10	10	20	40
6	Create				
Total		**20**	**20**	**60**	**100**

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AY 2021-22

Course Information

Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE612
Course Name	Multi body Dynamics
Desired Requisites:	Dynamics of machine, Kinematics and Theory of machine

Teaching Scheme (hrs/week)		**Examination Scheme (Marks)**			
Lecture	2	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 2**			

Course Objectives

1	Derive equations of motion for interconnected bodies in multi-body systems with three dimensional Motion.
2	Write programs to solve constrained differential equations for analyzing multi-body systems.
3	Lead team projects in academic research or the industry that require modelling and simulation of multi-body systems.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Implement and analyze methods of formulating equations of motion for Interconnected bodies.	Analyze
CO2	Simulate and analyze all types of static and dynamic behaviours of the multi-body systems including the kineto-static analysis.	Apply
CO3	Demonstrate an improved technical writing and presentation skills.	Create

Module	**Module Contents**	**Hours**
I	**Introduction:** The method of constraints for planar kinematic analysis. Revolute, prismatic, gear and cam pairs are considered together with other 2 degrees-of-freedom types of constraints.	4
II	**Basic principles for analysis of multi-body systems:** The automatic assembly of the systems of equations for position, velocity and acceleration analysis. Iterative solution of systems of nonlinear equations. Geometry of masses	4
III	**Dynamics of Planar Systems:** Dynamics of planar systems. Systematic computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element. Simple applications of inverse and forward dynamic analysis. Numerical integration of first-order initial value problems.	5
IV	**Kinematics of rigid bodies in space:** Reference frames for the location of a body in space. Euler angles and Euler parameters. The formula of Rodrigues. Screw motion in space. Velocity, acceleration and angular velocity.	4
V	**Kinematic analysis of spatial systems:** Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical and spherical). Equations of motion of constrained spatial systems.	5

VI	**Computation of Forces**: Computation of spatial generalized forces for external forces and for actuator-spring-damper element	4

Text Books	
1	Wittenburg, J., Dynamics of Systems of Rigid Bodies, B.G. Teubner, Stuttgart, 1977.
2	Kane, T.R, Levinson, D.A., Dynamics: Theory and Applications, McGraw-Hill Book Co., 1985
3	Nikravesh, P.E., Computer Aided Analysis of Mechanical Systems, Prentice-Hall Inc., Englewood Cliffs, NJ, 1988

References	
1	Roberson, R.E., Schwertassek, R., Dynamics of Multibody Systems, Springer-Verlag, Berlin, 1988.
2	Haug, E.J., Computer-Aided Kinematics and Dynamics of Mechanical Systems-Basic Methods, Allyn and Bacon, 1989.
3	Huston, R.L., Multibody Dynamics, Butterworth-Heinemann, 1990.
4	Schielen, W. ed., Multibody Systems Handbook, Springer-Verlag, Berlin, 1990

Useful Links	
1	https://www.youtube.com/watch?v=hik3wGrz8Ws&list=PL9-f9hWLZS60x5tV2kffJ8OZm8ds2IEZJ
2	https://www.youtube.com/watch?v=fEdz91oWrts
3	https://www.youtube.com/watch?v=tdkFc88Fw-M
4	https://www.youtube.com/watch?v=8AGseLCAc8w

CO-PO Mapping

	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2			2		
CO2	2				1	3
CO3	2				2	

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

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 be1 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	5	5	20	30
4	Analyze				
5	Evaluate	10	10	20	40
6	Create	5	5	20	30
Total		**20**	**20**	**60**	**100**

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AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE613
Course Name	Experimental Stress Analysis
Desired Requisites:	Strength of material, Material Science

Teaching Scheme		**Examination Scheme (Marks)**			
Lecture	2 Hrs/week	**T1**	**T2**	**ESE**	**Total**
Tutorial	-	20	20	60	100
Practical	-				
Interaction	-	**Credits: 2**			

Course Objectives	
1	To make the student familiar with techniques of experimental stress analysis.
2	To study strain gauge bridge configurations and related instrumentation to take readings.
3	To use different polariscope arrangements along with auxiliary equipment required for photoelasticity.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Analyze the photoelastic data by various methods.	Analyze
CO2	Determine the strains and stresses in photoelastic coating by using reflection polariscope.	Evaluate
CO3	Apply various methods and instrumentation for strain measurement.	Apply

Module	**Module Contents**	**Hours**
I	**Introduction to ESA:** 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	4
II	**Photo Elasticity:** Theory of Photo Elasticity, Optics related to photo elasticity- Ordinary light, Monochromatic light, polarized light, natural and artificial birefringence, Stress optic law in two dimensions atnormal incidence, material fringe value in terms of stress function, Effect of stressed model in plane polariscope–Isoclinics, Isochromatics, Criterion for selection of model materials, Properties of commonly employed photo elastic materials, Casting technique and machining of model, Conclusions pertaining to material	5
III	**Methods of Analysis:** Determination of direction of Principal stresses at given point, Determination of exact fringe order N and the principal stress difference ($\sigma 1 - \sigma 2$) at the given point, Separation methods: Method based on Hook's Law, Electrical analogy method, Oblique incidence method, Shear difference method. Scaling model results to prototype.	4
IV	**Strain Measurement Using Strain Gauges:** Introduction, types, construction and material, Gauge factor, cross or transverse 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:	5

	Measurement of force or load, Measurement of torque	
V	**Application of Strain Gauges:** 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, Delta rosette, Tee-rosette, Four element rectangular rosette, Rectangular rosette – Two and three element	4
VI	**Brittle Coating and Moir Method:** Brittle coating method - merits, demerits and applications, Moiré fringe method - merits, demerits and applications, Birefringent coating-principle and working of reflection polariscope.	4

Text Books	
1	Dally J. W., Riley W. F. "Experimental Stress Analysis", McGraw Hill, Third Edition 1991.
2	Dr.Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, Fourth Edition, 2015.

References	
1	Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B.,Ramachandra, K., "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, 1984.
2	Abdul Muben, "Experimental Stress Analysis", DhanpatRai& Co, First edition, 1987.
3	Window A. L., "Strain Gauge Techniques", Springer Publications, Second edition, 1992.

Useful Links	
1	https://www.youtube.com/watch?v=Ujtv5NY4Sq8
2	https://www.youtube.com/watch?v=n5oP5CswTAY&list=PL16JJHgYPkvMyabXO3RVs0YoqwSdMo4YT&index=8
3	https://www.youtube.com/watch?v=ZTXYwdPznkA&list=PL16JJHgYPkvMyabXO3RVs0YoqwSdMo4YT&index=27
4	https://www.youtube.com/watch?v=OUSDiI8UOJA&list=PL16JJHgYPkvMyabXO3RVs0YoqwSdMo4YT&index=30

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

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 be1 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	5	5	20	30
4	Analyze	5	5	20	30

5	Evaluate	10	10	20	40
6	Create				
Total		**20**	**20**	**60**	**100**

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(Government Aided Autonomous Institute)

AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE651
Course Name	A B Elective Lab 2: Advanced Finite Element Method Lab
Desired Requisites:	

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

Course Objectives	
1	Provide an opportunity to student to do work independently on a topic/ problem experimentation selected by him/her and encourage him/her to think independently on his/her own to bring out the conclusion under the given circumstances and limitations.
2	Encourage creative thinking process to help student to get confidence by successfully completing the mini, through observations, discussions and decision making process.
3	To enable student for technical report writing and effective presentations.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Solve field problems by using different techniques in mechanical design engineering	Apply
CO2	Design and develop suitable mechanical systems	Create
CO3	Prepare and present a detailed technical report based on mini project work	Evaluate

Course Content

Creation of prototype/ apparatus/ small equipment/experimental set up/ innovation of existing product/ analysis or simulation of a process/ experimental verification of principles in thrust areas of Advanced Finite Element Method.

Text Books	
1	Suitable books based on the contents of the mini project selected.

References	
1	Suitable books based on the contents of the mini project selected and research papers from Reputed national and international journals and conferences.

Useful Links	
1	As per the need of the mini project.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		2			1	

CO2			3			
CO3				1		1

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

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	10	**30**
Analyze				
Evaluate	10	10	10	**30**
Create	10	10	20	**40**
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE652
Course Name	A B Elective Lab 2: Multi-body Dynamics Lab
Desired Requisites:	

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

Course Objectives	
1	Provide an opportunity to student to do work independently on a topic/ problem experimentation selected by him/her and encourage him/her to think independently on his/her own to bring out the conclusion under the given circumstances and limitations.
2	Encourage creative thinking process to help student to get confidence by successfully completing the mini, through observations, discussions and decision making process.
3	To enable student for technical report writing and effective presentations.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Solve field problems by using different techniques in mechanical design engineering	Apply
CO2	Design and develop suitable mechanical systems	Create
CO3	Prepare and present a detailed technical report based on mini project work	Evaluate

Course Content

Creation of prototype/ apparatus/ small equipment/experimental set up/ innovation of existing product/ analysis or simulation of a process/ experimental verification of principles in thrust areas of Multi-body Dynamics.

Text Books	
1	Suitable books based on the contents of the mini project selected.

References	
1	Suitable books based on the contents of the mini project selected and research papers from Reputed national and international journals and conferences.

Useful Links	
1	As per the need of the mini project.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		2			1	
CO2			3			

CO3				1		1
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

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	10	**30**
Analyze				
Evaluate	10	10	10	**30**
Create	10	10	20	**40**
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem III
Course Code	5DE653
Course Name	A B Elective Lab 2: Experimental Stress Analysis lab
Desired Requisites:	

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

Course Objectives	
1	Provide an opportunity to student to do work independently on a topic/ problem experimentation selected by him/her and encourage him/her to think independently on his/her own to bring out the conclusion under the given circumstances and limitations.
2	Encourage creative thinking process to help student to get confidence by successfully completing the mini, through observations, discussions and decision making process.
3	To enable student for technical report writing and effective presentations.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Solve field problems by using different techniques in mechanical design engineering	Apply
CO2	Design and develop suitable mechanical systems	Create
CO3	Prepare and present a detailed technical report based on mini project work	Evaluate

Course Content

Creation of prototype/ apparatus/ small equipment/experimental set up/ innovation of existing product/ analysis or simulation of a process/ experimental verification of principles in thrust areas of Advanced Finite Element Method/ Multi-body Dynamics/ Experimental Stress Analysis etc.

The students will select the thrust area depending upon his/her professional elective 5.

Text Books	
1	Suitable books based on the contents of the mini project selected.

References	
1	Suitable books based on the contents of the mini project selected and research papers from Reputed national and international journals and conferences.

Useful Links	
1	As per the need of the mini project.

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1		2			1	
CO2			3			

CO3				1		1
The strength of mapping is to be written as 1,2,3; Where, 1:Low, 2:Medium, 3:High Each CO of the course must map to at least one PO.						

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	10	**30**
Analyze				
Evaluate	10	10	10	**30**
Create	10	10	20	**40**
Total Marks	**30**	**30**	**40**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	5DE691
Course Name	Dissertation Phase 2
Desired Requisites:	

Teaching Scheme (Hrs)		**Examination Scheme (Marks)**			
Lecture	-	**LA1**	**LA2**	**ESE**	**Total**
Tutorial	-	30	30	40	100
Practical	24				
Interaction	-	**Credits: 12**			

Course Objectives	
1	To develop the student to apply the knowledge gained to identify problem for research provide the solutions by self-study and interaction with stake holders
2	Acquire knowledge to tackle real world problems of societal concerns
3	Impart flexibility to the student to have increased control over his/ her learning.
4	Teachers would serve as mentor/facilitator of inquiry and reflection rather than as an instructor
5	Enhance student's learning through increased interaction with peers and colleagues.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Search the existing literature and identification of research problem	Analyze
CO2	Design and develop the solution for complex engineering problem	Evaluate
CO3	Create the new knowledge in the specialized field	Create

Course Contents

Students are expected to carry out independent research work on the chosen topic. In this semester it is expected that the student has carried out substantial research work including exhaustive literature survey, formulation of the research problem, development/fabrication of experimental set-up (if any/required) and testing, and analysis of initial results thus obtained. In fourth semester, the students continue their dissertation work. It is expected that the student has completed most of the experimental/computation works and analyzed the results so obtained as proposed in the synopsis. The work should be completed in all respects in this semester. The students are required to submit the dissertation work in the form of report as per the institute rule.

Text Books	
1	As per the research topic

References	
1	National and International Journals

Useful Links	
1	https://nptel.ac.in/courses/110/104/110104073/

CO-PO Mapping	
	Programme Outcomes (PO)

	1	2	3	4	5	6
CO1	1			1		2
CO2	1		1		2	2
CO3		2				2

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

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

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	5DE671
Course Name	Techno-Socio Activity
Desired Requisites:	

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

Course Objectives	
1	To record student performance in co-curricular and extra-curricular activities over four years will be considered.
2	To encourage the students to participate in activities that help develop leadership skills, team integrity, coordination skills, Time management, Communications skills, Interviewing skills etc.
3	To highlight importance of social responsibility.

Course Outcomes (CO) with Bloom's Taxonomy Level At the end of the course, students will be able to,		
CO1	Notice an improvement in his/her understanding and presentation skills.	Apply
CO2	Understand and value the importance of working in a diversified team.	Analyze
CO3	Demonstrate the soft skills like presentation skills, technical report writing etc.	Evaluate

Course Contents

The guide will be mentoring a given student batch for the duration of two years. The students shall submit proof of their achievements in various extra and co-curricular activities related to technical, cultural and social causes from first year to second year. The faculty will evaluate the students' performance at the end of 4thsemester, based on the rubrics provided by the department from time to time.

Text Books	
1	Not applicable

References	
1	Not applicable

Useful Links	
1	Not applicable

CO-PO Mapping						
	Programme Outcomes (PO)					
	1	**2**	**3**	**4**	**5**	**6**
CO1	2				3	
CO2		1			2	
CO3			2		3	

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

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

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information

Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	5DE621
Course Name	Design for Manufacturing and Assembly
Desired Requisites:	Concept knowledge of machine design, manufacturing processes

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

Course Objectives

1	To provide the students the knowledge of different steps involved in the Product Development Cycle.
2	To prepare the students to use knowledge of the manufacturing process.
3	To prepare the students to succeed as designer in industry /technical professions.

Course Outcomes (CO) with Bloom's Taxonomy Level

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

CO1	Explain the product development cycle	Analyze
CO2	Study the principles of assembly to minimize the assembly time.	Evaluate
CO3	Interpret the effect of manufacturing process and assembly operations on the cost of product.	Apply

Module	**Module Contents**	**Hours**
I	Introduction Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design, Selection of Materials and Shapes	6
II	Properties of Engineering Materials, Selection of Materials–I, Selection of Materials–II, Case Studies–I, Selection of Shapes, Co-selection of Materials and Shapes, Case Studies–II.	6
III	Selection of Manufacturing Processes, Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes.	6
IV	Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing, Co-selection of Materials and Processes, Case-Studies–III	6
V	Design for Assembly, Review of Assembly Processes, Design for Welding–I, Design for Welding–II, Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment, Case-Studies-IV.	10
VI	Design for Reliability, Failure Mode and Effect Analysis and Quality, Design for Quality, Design for Reliability, Approach to Robust Design, Design for Optimization,	6

Text Books

1	Rao S. S., Engineering Optimization: theory and practice, John Wiley, 2nd edition, 1996.
2	Ashby M. F. and Johnson K, Materials and Design - the art and science of material selection inProduct design, Pearson publications, 3rd edition, 2002.

3	G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, 2nd edition, 2006.
References	
1	Bralla J G, Handbook for Product Design for Manufacture, McGraw Hill, 2nd edition, 2003.
2	ASTM Design handbook
3	Courtney T H, Mechanical Behaviour of Materials, McGraw Hill, 4th edition, 2008
4	Swift K G and Booker J D, Process selection: from design to manufacture, London: Arnold,1997
Useful Links	
1	https://nptel.ac.in/courses/107/108/107108010/
2	https://nptel.ac.in/courses/112/108/112108150/
3	https://nptel.ac.in/courses/112/101/112101005/
4	https://youtu.be/LBVeK_7I0PM

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

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 be1 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	10	10	30	50
4	Analyze	05	05	15	25
5	Evaluate	05	05	15	25
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	5DE622
Course Name	Product Lifecycle Management
Desired Requisites:	Concept knowledge of product design, management

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

Course Objectives	
1	To prepare students to develop products by technical and managerial and software skills.
2	To make the students familiar with increased product complexity and to maintain product quality.
3	To develop skills to identify the gaps between current product development process.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Discuss the importance and the concept of Product Lifecycle Management and its need.	Understand
CO2	Exploit the methodology to set the Product Lifecycle Management Vision and Develop Product Lifecycle Management strategy	Apply
CO3	Analyze the recent developments to perform product structure modelling with relationship	Analyze

Module	**Module Contents**	**Hours**
I	Product life cycle – Introduction, growth, maturity & decline, Product Lifecycle, Management-Definition & Overview, Background for Product Lifecycle Management-corporate challenges, Need of Product Lifecycle Management, Components/Elements of Product Lifecycle Management, Emergence of Product Lifecycle Management, Significance of Product Lifecycle Management - life cycle problems to be resolved.	6
II	Product Lifecycle Management Life cycle model- plan, design, build, support & dispose. Threads of Product Lifecycle Management computer aided design (CAD), engineering data management (EDM), Product data management (PDM), computer integrated manufacturing (CIM). Weaving the threads into Product Lifecycle Management, comparison of Product Lifecycle Management to Engineering resource planning (ERP). Product Lifecycle Management characteristics - singularity, cohesion, traceability, reflectiveness, Information Mirroring Model. External drivers- scale, complexity, cycle times, globalization & regulation. Internal drivers - productivity, innovation, collaboration & quality. Boardroom drivers – income, revenues & costs	7
III	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 and Prototype development. Virtual testing and collateral. Introduction to Digital Manufacturing.	6

IV	Product life cycle management system- system architecture, Information models and product structure, Information model, the product information data model, the product model, functioning of the system. Reasons for the deployment of Product Lifecycle Management systems.	6
V	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 Product Lifecycle Management vision, The Product Lifecycle Management Strategy, Principles for Product Lifecycle Management strategy, Preparing for the Product Lifecycle Management strategy.	7
VI	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.	7

Text Books	
1	Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006. ISBN 0071452303.
2	Antti Sääksvuori, Anselmi Immonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
3	Stark, John. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer- Verlag, 2004. ISBN 1852338105.
4	Kari Ulrich and Steven D. Eppinger, Product Design & Development, McGraw Hill International Edns, 1999.
References	
1	Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo, 1974.
2	Effective Product Design and Development – by Stephen Rosenthol, Business One Orwin, Homewood 1992 ISBN 1-55623-603-4.
3	Clement, Jerry; Coldrick, Andy; & Sari, John. Manufacturing Data Structures, John Wiley & Sons, 1992. ISBN 0471132691
4	Clements, Richard Barrett. Chapter 8 ("Design Control") and Chapter 9 ("Document Control") in Quality Manager's Complete Guide to ISO 9000, Prentice Hall, 1993. ISBN 013017534X.
Useful Links	
1	https://www.youtube.com/watch?v=MsnbqLWjlmA&list=PLeL2LKQLdbQvCnx
2	https://nptel.ac.in/courses/112/107/112107217/
3	https://www.youtube.com/watch?v=NDcaDUKQutE&list=PLSGws_74K018yZOnbSaqW
4	https://www.youtube.com/watch?v=m-OMvTWf9mE

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

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 be1 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	10	10	30	50
3	Apply	05	05	15	25
4	Analyze	05	05	15	25
5	Evaluate				
6	Create				
Total		**20**	**20**	**60**	**100**

Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

AY 2021-22

Course Information	
Programme	M. Tech. (Mechanical Design Engineering)
Class, Semester	Second Year M. Tech., Sem IV
Course Code	5DE623
Course Name	Advanced Engineering Materials
Desired Requisites:	

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

Course Objectives	
1	To demonstrate understanding Mechanical properties of materials and influence of imperfections over mechanical properties.
2	To demonstrate understanding phase diagrams and their use in predicting phase transformation and microstructure also understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact.
3	To recognize Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites and understand the economic considerations in usage and recycling of materials inhuman use.

Course Outcomes (CO) with Bloom's Taxonomy Level		
At the end of the course, students will be able to,		
CO1	Apply knowledge of mechanics, physical and chemical properties of materials including metals, ceramics, polymers and composites and imperfections and their effects on mechanical properties of materials and cause of failure.	Apply
CO2	Examine phase diagrams in predicting phase transformation and microstructure	Evaluate
CO3	Recognize Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composite.	Create

Module	**Module Contents**	**Hours**
I	**Introduction, Atomic Structure, Interatomic Bonding and Structure of Crystalline Solids:** Historical perspective of Materials Science. Why study properties of materials? Classification of materials. Advanced Materials, Future materials and modern materials, Atomic structure. Atomic bonding in solids, Crystal structures, Crystalline and noncrystalline materials. Miller indices. Anisotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers. Structure and properties of ceramics.	7

II	**Imperfections in Solids and Mechanical Properties of Metals, Diffusion, Dislocations and Strengthening Mechanisms:** Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Strengthening by second phase particles. Optimum distribution of particles. Lattice resistance to dislocation motion.	7
III	**Phase Diagrams:** Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbon system.	7
IV	Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep Generalized creep behaviour. Stress and temperature effects.	7
V	**Applications and Processing of Metals and Alloys, Polymers, Ceramics, and composites:** Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. Precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites. Fibre reinforced composites. Structural composites.	7
VI	**Electrical, Thermal, Optical and Magnetic Properties and economic Considerations:** Electrical conduction. Semi conductivity. Super conductivity. Dielectric behaviour. Ferroelectricity. Piezoelectricity Heat capacity. Thermal expansion. Thermal conductivity. Thermal stresses Diamagnetism and Para magnetism. Ferromagnetism. Antiferromagnetism and ferrimagnetism. Influence of temperature on magnetic behaviour. Economic, Environmental and Social Issues of Material Usage - Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design	5
Text Books		
1	Materials Science and Engineering, William D. Callister, Jr, John Wiley & sons, 07.	
2	Modern Physical Metallurgy and Material Engineering, Science, Process, application, Smallman R.E., Bishop R J, Butterworth Heinemann, Sixth Ed., 1999.	
3	Essentials of Materials Science &Engineering, Donald R. Askeland, Wendelin J. Wright,PradeepFulay	
References		
1	Sidney H. Avener, Physical Metallurgy, Tata McGraw Hill Education Private Limited, 2nd Edition, 1997.	
2	George E. Dieter, Mechanical Metallurgy, Tata McGraw Hill Publication, Si Metric Edition, 3rdRevised edition, 2013.	
3	Ashok Sharma, Rajan, Heat Treatment: Principles & Techniques, Phi Learning Pvt. Ltd-New Delhi, 2nd edition, 2011.	
Useful Links		

1	https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_02_m.pdf
2	https://www3.nd.edu/~amoukasi/CBE30361/Lecture_Defects_2014.pdf
3	https://youtu.be/7x3c8trbtQs
4	https://nptel.ac.in/courses/112/108/112108150/

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

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 be1 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	05	05	15	25
4	Analyze				
5	Evaluate	05	05	15	25
6	Create	10	10	30	50
Total		**20**	**20**	**60**	**100**