Rashtreeya Sikshana Samithi Trust

R.V COLLEGE OF ENGINEERING

(Autonomous Institution affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysuru Road
Bengaluru – 560 059

SCHEME & SYLLABUS

3rd Semester

B.E- Industrial Engineering and Management

(2016 Scheme)

Department Vision

Imparting innovation and value based education in Industrial Engineering and Management for steering organizations to global standards with an emphasis on sustainable and inclusive development.

Department Mission

IEM M1. To impart scientific knowledge, engineering and managerial skills for driving organizations to global excellence.

IEM M2. To promote a culture of training, consultancy, research and entrepreneurship interventions among the students.

IEM M3. To institute collaborative academic and research exchange programs with national and globally renowned academia, industries and other organizations.

IEM M4. To establish and nurture centers of excellence in the niche areas of Industrial and Systems Engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO	Description
PEO1	Conceive, design, implement and operate integrated systems, focus on appropriate measures of performance at strategic, tactical and operational levels.
PEO2	Develop competency to adapt to changing roles for achieving organizational excellence.
PEO3	Design and develop sustainable technologies and solutions for betterment of society.
PEO4	Pursue entrepreneurial venture with a focus on creativity and innovation for developing newer products, processes and systems.

PROGRAM OUTCOMES (POs)

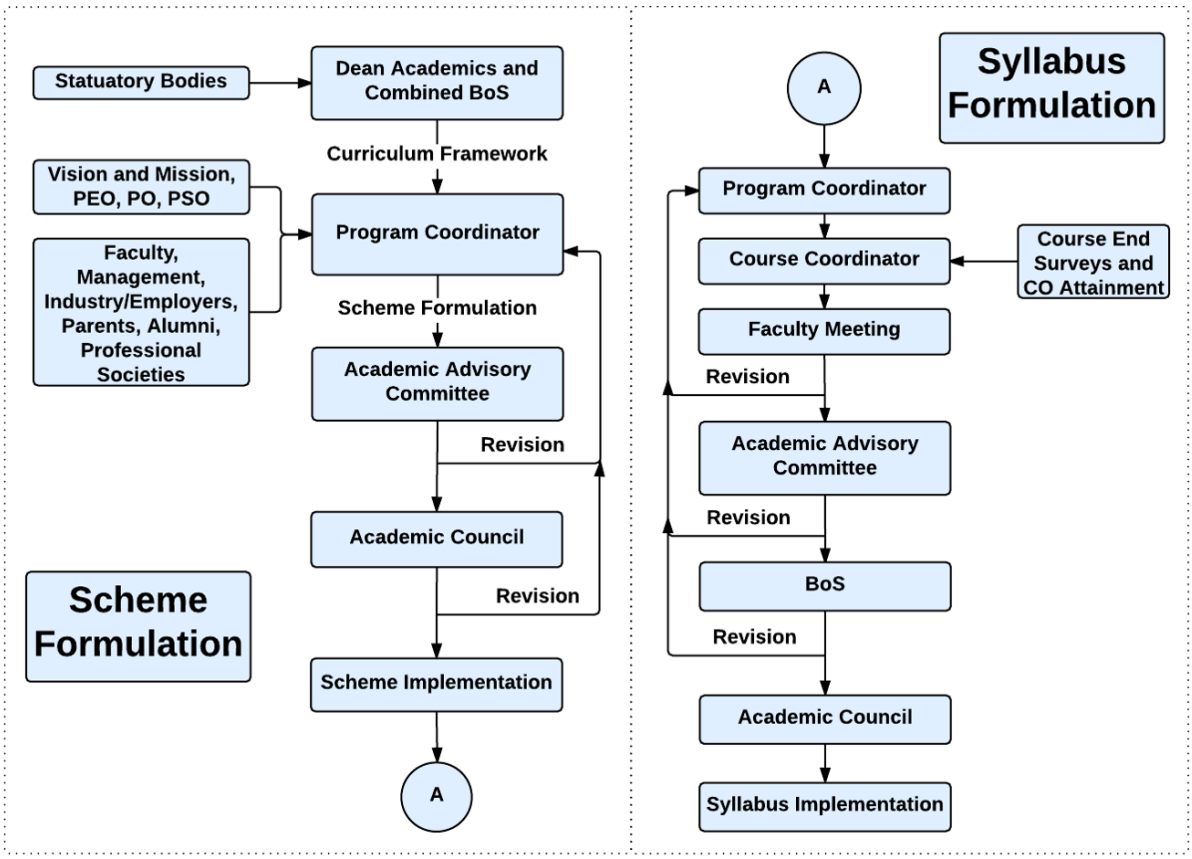
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet t h e specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with t h e society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

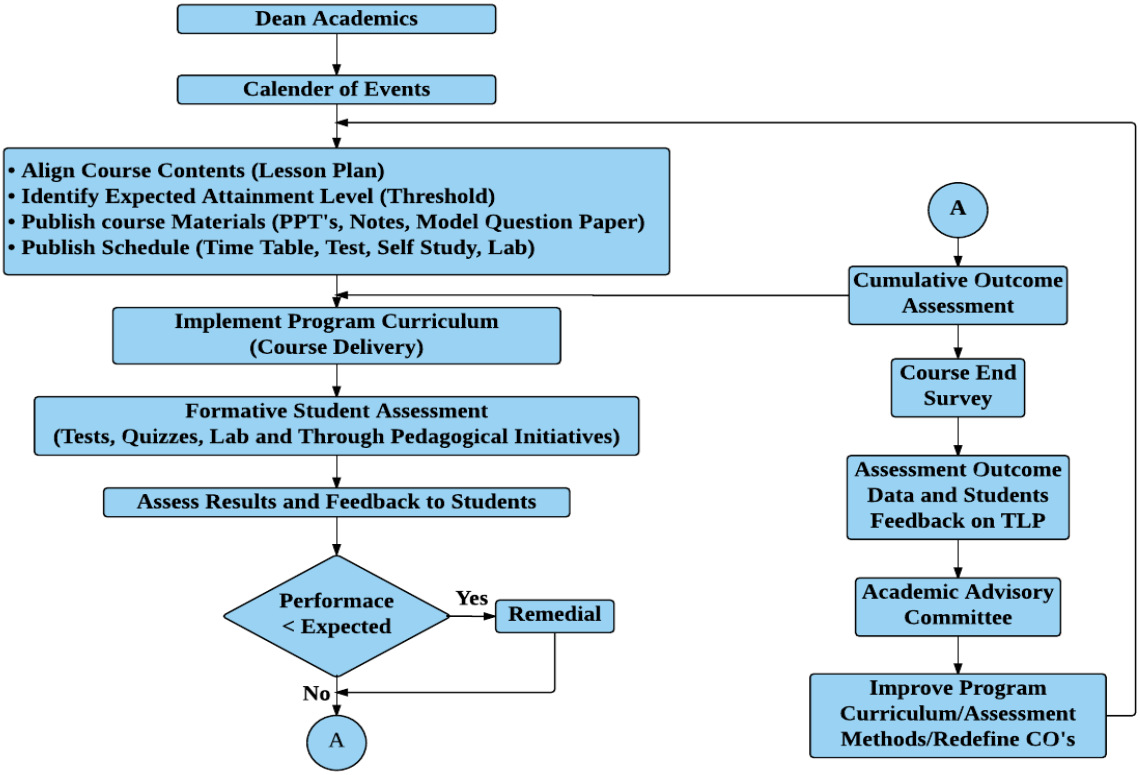
PSO	Description
PSO1	Design, develop, implement and improve integrated systems that include people, materials, information, equipment and energy.
PSO2	Apply statistical and simulation tools, optimization and metaheuristics techniques for analysis of various systems leading to better decision making.
PSO3	Demonstrate the engineering relationships between the management tasks of planning, organization, leadership, control, and the human element in various sectors of economy.

Lead Society: Institute of Industrial Engineers (USA)

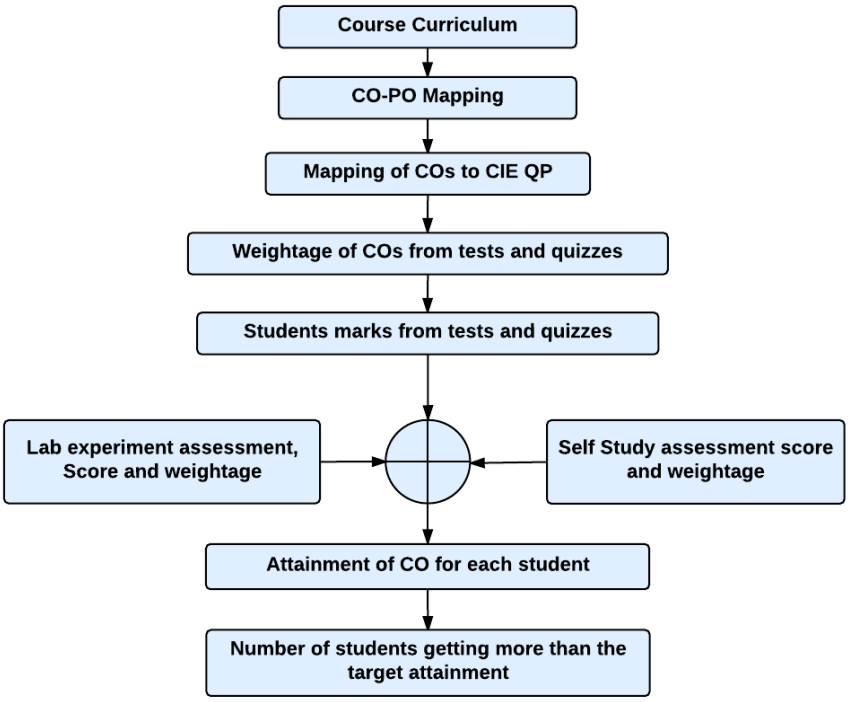
Curriculum Design Process



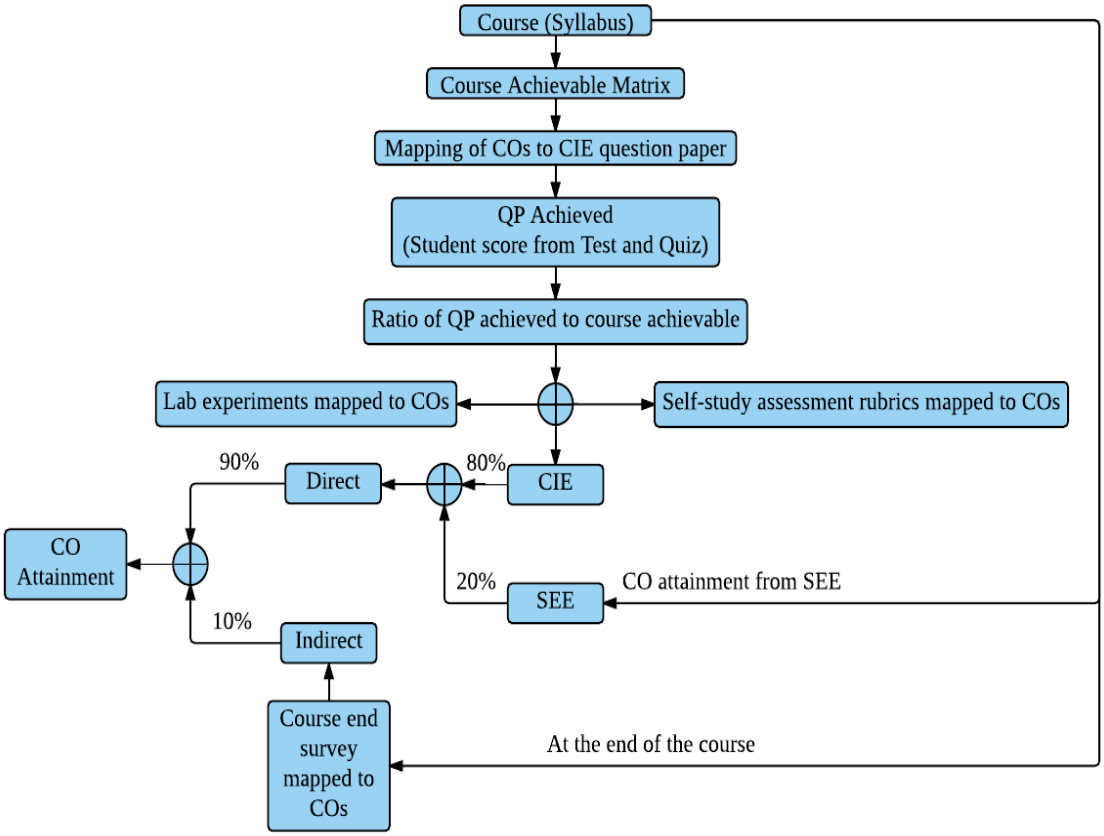
Academic Planning and Implementation



Process for Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process

Guidelines for Fixing Targets

- The target may be fixed based on last 3 years' average attainment

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DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT

SCHEME OF TEACHING AND EXAMINATION

THIRD SEMESTER								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**				**Total Credits**
				Lecture	**Tutorial**	**Practical**	**SS (EL)**	
1	16MA31C	Applied Mathematics-III	Maths	3	1	0	0	4
2	16EM32B	Engineering Materials #	ME	2	0	0	0	2
3	16IM33	Principles of Fluid Mechanics and Thermodynamics	IEM	3	0	0	1	4
4	16ME34	Mechanics of Materials	ME	3	1	1	0	5
5	16IM35	Measurements & Metrology	IEM	3	0	1	1	5
6	16IM36	Manufacturing Processes	IEM	3	0	1	1	5
7	16DMA37	Bridge Course Mathematics	Maths	2	0	0	0	0
		Total No. of Credits						**25**
		No. Of Hrs.		**17**	**4**	**6**	**12****	**39**

*Mandatory Audit course for lateral entry diploma students

**Non contact hours

 # ME/IM/AS Common

1Hr. Theory= 1 credit **2Hrs. Practical=1credit** **2Hrs. Tutorial=1 credit** **4Hrs. SS(EL) = 1 Credit**

- The EC,CS,EE,IS,TE,EI programs will have 16DCS37 in 3rd semester and 16DMA47 in 4th semester.
- The ME,CH,IM,CV,BT,AS programs will have 16DMA37 in 3rd semester and 16DSC47 in 4th semester

Programs	Semester	Course Code/ Course Title	Semester	Course Code / Course Title
EC,CS,EE,IS,TE,EI	3	**16DCS37** Bridge Course C Programming	4	**16DMA47** Bridge Course Mathematics
ME,CH,IM,CV,BT,AS	3	**16DMA37** Bridge Course Mathematics	4	**16DCS47** Bridge Course C Programming

- The EC,CS,EE,IS,TE,EI programs will have 16ET32 in 3rd semester and 16EM42/16EB42 in 4th semester.
- The ME,CH,IM,CV,BT,AS programs will have 16EM32/16EB32 in 3rd semester and 16ET42 in 4th semester

Programs	Semester	Course Code/ Course Title	Semester	Course Code / Course Title
EC,CS,EE,IS,TE,EI	3	**16ET32** Environmental Technology	4	**16EM42/16EB42** Engineering Materials/Biology for Engineers
ME,CH,IM,CV,BT,AS	3	**16EM32/12EB32** Engineering Materials/Biology for Engineers	4	**16ET42** Environmental Technology

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DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT

SCHEME OF TEACHING AND EXAMINATION

FOURTH SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				**Total Credits**
				Lecture	**Tutorial**	**Practical**	**SS (EL)**	
1	16IM41	Basic of Machine Design & Drawing	IEM	3	0	1	0	4
2	16ET42	Environmental Technology#	BT	2	0	0	0	2
3	16IM43	Engineering Statistics	IEM	3	1	0	1	5
4	16IM44	Computer Integrated Manufacturing	IEM	3	0	1	1	5
5	16IM45	Design of Work Systems	IEM	3	0	1	0	4
6	16IM46	Operations Research	IEM	3	1	0	1	5
7	16HS47	Professional Practice-II (Team Work and Professional Ethics)	HSS	0	0	0	0	1
8	16DCS48	Bridge Course C Programming **	CSE	2	0	0	0	0
		Total No. of Credits						**26**
		No. Of Hrs.		**17**	**4**	**6**	**12****	**39**

*Mandatory Audit course for lateral entry diploma students **Non contact hours

$ 3 days (18 Hrs) in 3RD semester and 3 days (18 Hrs) in 4th semester, in the event of student not able to take the regular allotment, may have to complete this credit by attending other branch program.

[#] BT, CV, CH, Chemistry will handle classes

1Hr. Theory= 1 credit **2Hrs. Practical=1credit** **2Hrs. Tutorial=1 credit** **4Hrs. SS(EL) = 1 Credit**

Bridge Course Mathematics** / Bridge Course C Programming **		
EC,CS,EE,IS,TE,EI	16DCS37	16DMA47
ME,CH,IM,CV,BT,AS	16DMA37	16DSC47
Engineering Materials/Biology for Engineers AND Environmental Technology		
EC,CS,EE,IS,TE,EI	12ET32	12EM42/12EB42
ME,CH,IM,CV,BT,AS	12EM32/12EB32	12ET42

	What		**To whom**	**Frequency of conduction**	**Max Marks**	**Evidence**	**Contribution to Course Outcome**		
Direct Assessment Methods	CIE	Quiz	Students	Three	30	Answer Scripts	80%	100%	90%
		Test		Two	60/50				
		Assignment/Self-study		2 phases	10/20	Reports / Record Books			
		Laboratory		Weekly	50				
	SEE	Semester End Examination		End of every semester Consisting of Part-A and Part-B	100	Answer Scripts	20%		
		Semester End Laboratory		End of every semester laboratory	50				
Indirect Assessment methods	Course End Survey		Students	End of course		Questionnaire Based on COs	10%		

Semester - III		
APPLIED MATHEMATICS - III (COMMON TO BT, IEM)		
Course Code: 16MA31C		**CIE Marks: 100**
Hrs/Week: L:T:P:S : 3:1:0:0		**SEE Marks: 100**
Credits: 04		**SEE : 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Identify and solve initial value problems, interpret the physical significance of solutions using Laplace Transforms and Inverse Laplace transforms.
2	Understand the basics of Matrix theory, Eigen values and Eigen vectors, its applications for finding solution of system of linear equations
3	Analyze the given set of experimental data and fit suitable approximating curves.
4	Learn to formulate and solve LPP using optimization techniques.

UNIT-I	
LAPLACE TRANSFORM Existence and uniqueness of Laplace Transform (LT), Transform of elementary functions, RoC. Properties of LT : Linearity, change of scale and first shifting. Transform of fuInction multiplied by t^n, division by t, derivatives and integral. LT of periodic function, Heaviside unit step function, Unit impulse function. Heaviside shift (second shift) theorem.	**08 Hrs**
UNIT-II	
INVERSE LAPLACE TRANSFORM Definition, properties of inverse Laplace transform, evaluation using different methods. Convolution theorem, problems. Application to solve ordinary linear differential equations and simultaneous differential equations.	**08 Hrs**
UNIT-III	
LINEAR ALGEBRA Rank of matrices-rank of matrix by Echelon form, consistency of system of linear equations- homogeneous and non-homogeneous equations, Gauss elimination, Gauss Jordan, Gauss Seidel methods, Eigen values and Eigen vectors-properties, largest Eigen value by Power method.	**08 Hrs**
UNIT-IV	
STATISTICS Curve fitting by method of least squares, fitting of curves-linear, parabolic, exponential, power functions, correlation, regression analysis – problems.	**08 Hrs**
UNIT-V	
LINEAR PROGRAMMING Mathematical formulation of Linear Programming Problem, Graphical method, Simplex method and Big M method.	**08 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Demonstrate the understanding of Laplace transforms and inverse Laplace transforms significance of matrices, statistical measures and optimization techniques.
2	Solve differential equations using Laplace transforms and system of equations using matrix methods, find curve of best fit for observed data and, optimization problems using LPP.
3	Apply acquired knowledge to construct frequency domain functions, use Least square method and find correlation and regression and solve LPP using Graphical methods.
4	Estimate definite integrals using Laplace transform, Eigen values , Eigen vectors and solve

	LPP using Simplex methods

Reference Books	
1.	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 40th Edition, 2007, ISBN: 81-7409-195-5.
2.	B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2008, ISBN: 13-978-07-063419-0; ISBN: 10-0-07-063419-X.
3.	Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2007, ISBN: 978-81-265-3135-6.
4.	N.P Bali & Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications, 7th Edition, 2010, ISBN: 978-81-7008-992-6.

Continuous Internal Evaluation (CIE) (Theory – 100 Marks)							
Evaluation method	Quiz -1	Test -1	Quiz -2	Test -2	Quiz -3	Assignment	Total
Course with Self-study	10	30	10	30	10	10	100

Semester End Evaluation Theory (100)	
Part- –A Objective type questions	**20**
Part –B There should be five questions from five units. Each question should be for maximum of 16 Marks. The **UNIT-1**, **UNIT-4** and **UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**
Total	**100**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	M	-	-	-	-	-	-	-	L	-	L
CO2	H	M	M	L	-	-	-	-	-	L	-	L
CO3	H	H	M	M	M	-	-	-	-	L	-	L
CO4	H	H	H	H	M	-	-	-	-	L	-	L

Low-1 Medium-2 High-3

Semester: III		
Course Title: ENGINEERING MATERIALS		
Course Code:	**16EM32B**	**CIE Marks: 50**
Hrs/Week: L:T:P:S:	**2:0:0:0**	**SEE Marks: 50**
Credits:	**2**	**SEE Duration: 2 Hrs**
Course Learning Objectives: The students will be able to		
1	Familiarize with atomic structure of metals, imperfections, diffusion mechanisms and theories	

	of plastic deformation.
2	Understand concept of phase diagram and construct phase diagram of different alloy system.
3	Differentiate between steel and cast iron with the help of Iron carbon Diagram.
4	Demonstrate the skills to explain Time Temperature Transformation diagram and different types of heat treatment process.
5	Explain the composition, properties and application of ferrous and non-ferrous materials.
6	Explain the concept of corrosion in materials and their prevention.
7	The concept of selection of materials for automotive, aerospace, marine and domestic application.

UNIT-I	
Crystallography, defects in materials and deformation: Crystal structure - BCC, FCC and HCP structures - Unit cell - Crystallographic planes and directions, Miller indices. Crystal imperfections, point, line, planar and volume defects - Grain size, ASTM grain size number. Frank Reed source of dislocation, Elastic and Plastic deformation, Slip and Twinning, strain hardening and Bauschinger effect.	**06 Hrs**
UNIT-II	
Alloys and Phase Diagrams: Constitution of alloys - solid solutions - Substitutional and Interstitial. Phase diagrams - construction of isomorphus phase diagram, Lever rule, Iron-Iron carbide equilibrium diagram, different types of invariant reactions, slow cooling of steels.	**04 Hrs**
UNIT-III	
Heat Treatment: Full annealing, Stress relief annealing, Normalizing, Hardening and Tempering of steel. Isothermal transformation diagram of eutectoid steel - cooling curves imposed on I.T diagram, Critical cooling rate, Hardenability, Jomminy end quench test - austempering, martempering, case hardening, carbursing, nitriding, cyaniding. Flame and Induction hardening.	**06 Hrs**
UNIT-IV	
Ferrous and Non Ferrous Metals: Alloying of steel (Mn, Si, Cr, Mo, V, Ti and W) - stainless steels and tool steels - High Speed Low alloy (HSLA). Cast Iron-Gray, white, malleable, spheroidal, graphite cast iron. Composition, Properties and applications of Copper and Copper alloys - Brass and Bronze, Aluminium and Aluminium alloys, Titanium and Titanium alloys.	**04 Hrs**
UNIT-V	
Corrosion: Types of corrosion- Galvanic corrosion, Pitting corrosion, Erosion corrosion, Crevice corrosion; intergranular and transgranular corrosion, hydrogen cracking and embrittlement, corrosion prevention. Materials for Automotive, aerospace, marine and domestic applications.	**04 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the concepts of crystal structure, microstructure and deformation. (L1- L2)
2	Construct phase diagram of alloy systems and Iron Carbon phase diagram. (L3)

3	Relevance of TTT diagram in design and control of heat treating process. (L4)
4	Understand ferrous and Non Ferrous materials and their alloys used for different application. (L5)

Reference Books	
1.	William F Smith., 'Material Science and Engineering', Tata McGraw Hill, 4th Edition, 2008, ISBN-(13 digits): 978-0-07-066717-4; ISBN-(10 digits): 0-07-066717-9
2.	Sidney H Avner., 'Introduction to Physical Metallurgy', Tata McGraw Hill, 1997, ISBN-(13 digits): 978-0-07-463006-8; ISBN-(10 digits): 0-07-463006-7
3.	William D. Callister, Jr., 'Materials Science and Engineering An Introduction', John Wiley and Sons, Inc., 6th Edition, 2004, ISBN: 9812-53-052-5

Continuous Internal Evaluation (CIE) (Theory – 50 Marks)	
Evaluation method	Course with Assignment/ Self-study
Quiz -1	5
Test -1	20
Quiz -2	5
Test -2	20
Total	**50**

Semester End Evaluation Theory (50)	
Part- –A Objective type questions	**10**
Part –B There should be five questions from five units. Each question should be for maximum of Marks. The **UNIT-1**, **UNIT-4** and **UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**40**
Total	**50**

	What		**To whom**	**Frequency of conduction**	**Max Marks**	**Evidence**	**Contribution to Course Outcome**		
Direct Assessment Methods	CIE	Quiz	Students	Two	20	Answer Scripts	80%	100%	90%
		Test		Two	30/20				
	SEE	Semester End Examination		Consisting of Part-A and Part-B	50	Answer Scripts	20%		

Indirect Assessment methods	Course End Survey	Students	End of course		Questionnaire Based on COs	10%

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1		**H**	**L**				**M**					**L**
CO2	**H**	**H**	**L**							**L**		
CO3	**M**	**H**			**M**							
CO4		**H**	**L**			**M**						**L**

Low-1 Medium-2 High-3

PRINCIPLES OF FLUID MECHANICS AND THERMODYNAMICS		
Course Code: 16IM33		**CIE Marks: 100**
Hrs/Week: L:T:P:S: 3:0:0:4		**SEE Marks: 100**
Credits: 04		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Recognize the various types of fluid flow problems encountered in practice.	
2	Apply the conservation of mass equation to balance the incoming and outgoing flow rates in a flow system.	
3	Develop the general energy balance applied to closed system.	
4	Apply the first law of thermodynamic to open and closed system.	
5	Apply the second law of thermodynamics to cycles & cyclic devices	

UNIT-I	
Introduction, Basic Concepts & properties of fluid: Definition of fluid, Application areas of fluid mechanics, The No-slip condition, classification of fluids, Density & Specific gravity, vapor pressure and capitation, Compressibility &Bulk modulus, Viscosity, Surface tension & capillarity. Numerical problems based on fluid properties only.	**7 Hrs**
UNIT-II	
Mass, Bernoulli Equations: Conservation of mass, The Linear momentum equation, conservation of energy, Mass & volume flow rates, deforming control volumes, mass balance for steady flow process, Acceleration of fluid particle, Derivation of Bernoulli equation, Force balance across streamlines, unsteady compressible flow, Limitation on the use of Bernoulli equation, Hydraulic Grade Line and Energy grade Line, Application of Bernoulli equation, General energy equation .	**9 Hrs**
UNIT-III	
Introduction, Basic Concepts of Thermodynamics: Thermodynamics & Energy, Application and areas of thermodynamic, Systems and control volumes, Properties of a system, Density & Specific gravity, State & Equilibrium, process and cycles, temperature & the Zeroth law of thermodynamic. Temperature Scales, forms of energy, energy transfer by heat, energy transfer by work, Mechanical forms of work.	**7 Hrs**
UNIT-IV	

Energy on analysis of closed systems: Moving boundary work, energy balance for closed system, specific heats, Internal Energy, Enthalpy, & Specific heats of Ideal gases, Energy analysis of steady flow systems, and Energy analysis of Unsteady flow processes.	**7 Hrs**
UNIT-V	
The Second law of thermodynamics: Introduction to the second law, Thermal Energy Reservoirs, Heat engines, thermal efficiency, Kelvin Planck statement, Refrigerators & heat pumps, coefficient of performance, Clausius statement, equivalence of the two statements, Perpetual motion machines, Reversible & irreversible process, The Carnot cycle, The Carnot heat engine, Refrigerator and heat pump .	**9 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Apply the properties of fluid in engineering design.
2	Apply the first law of thermodynamics on closed systems.
3	Apply the second law of thermodynamics for control volumes undergoing steady state flow processes.

Reference Books	
1.	Yunus A Cencgal and John M Cimbala, Fluid mechanics – Fundamentals & Application, Tata McGraw Hill publications, 2nd Edition, 2006, ISBN: 978-0-07-070034-5.
2.	Yunus A Cencgal and Michael A. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill publications, 5th Edition, 2006, ISBN: 0072884959.

In case of a course having only theory, the following minimum guidelines may be followed.

Continuous Internal Evaluation (CIE) (Theory – 100 Marks)							
Evaluation method	Quiz -1	Test -1	Quiz -2	Test -2	Quiz -3	Self-study (EL)	Total
Course with Self-study	10	25	10	25	10	20	100

Semester End Evaluation Theory (100)	
Part- –A Objective type questions	**20**
Part –B There should be five questions from five units. Each question should be for maximum of 16 Marks. The **UNIT-1**, **UNIT-4** and **UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**
Total	**100**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1				H							
CO2				H	M					L	
CO3			M	H	M			M		L	
CO4		M		H					L	L	

Low-1 Medium-2 High-3

MECHANICS OF MATERIALS		
Course Code: 16ME34		**CIE Marks: 100 + 50 = 150**
Hrs/Week: L:T:P:S: 3:2:2:0		**SEE Marks: 100 + 50 = 150**
Credits: 05		**SEE Duration: 3 Hrs (T) + 3 Hrs (P)**
Course Learning Objectives: The students will be able to		
1	To understand mechanics of deformable bodies and apply them in analysis and design problems.	
2	To analyze a body subjected to two dimensional stress systems	
3	To understand the behavior of a structural member in flexure.& Torsion	
4	To evaluate the slope and deflection in beams subjected to loading.	
5	To study the stability of columns and struts.	
6	To predict the stress distribution in beams, pressure vessels, shafts, etc	

PART A	
UNIT-I	
Review of stress, strain & Elastic Constants: Stress, Strain, relationship among elastic constants, Volumetric strain. (No questions to be set on these topics) **Thermal stresses and strains** (compound bars not included). Numerical problems. **Two Dimensional Stress System:** Introduction, Stress components on inclined planes, Principal Stresses, Principal planes, Mohr's circle of stress Numerical problems.	**05 Hrs**
UNIT-II	
Bending moment and shear force in beams : Introduction, Types of beams, Loads and Reactions, Shear forces and bending moments, Rate of loading, Sign conventions, Relationship between shear force and bending moments, Shear force and bending moment diagrams subjected to concentrated loads, uniform distributed load (UDL) for different types of beams.(UVL not included) **Bending stress in beams:** Introduction, Assumptions in simple bending theory, Derivation of Bernoulli's equation, Modulus of rupture, Section modulus, Flexural rigidity, Bending stress distribution in beams of various sections, Beam of uniform strength (No numerical on beam of uniform strength) **Shear stresses in beams**: Expression for horizontal shear stress in beam, Shear stress diagram for simple rectangular and I section and T sections only. Numerical problems.	**10 Hrs**

UNIT-III	
Deflection of determinate Beams: Introduction, Definitions of slope, Deflection, Elastic curve, Derivation of differential equation of flexure, Sign convention, Double integration method, Slope and deflection using Macaulay's method for prismatic beams and overhanging beams subjected to point loads, UDL and couple. Numerical problems. **Thick and thin cylinders:** Stresses in thin cylinders, Changes in dimensions of cylinder (diameter, length and volume), Thick cylinders subjected to internal and external pressures (Lame's equation), (Compound cylinders not included).	**10 Hrs**
UNIT-IV	
Torsion of shafts: Assumptions in theory of pure torsion, Torsion equations, Torsional rigidity and modulus of rupture, Power transmitted, Comparison of solid and hollow circular shafts. Numerical problems.	**04 Hrs**
UNIT-V	
Analysis of columns and struts: Introduction, Euler's theory on columns, Effective length, Slenderness ratio, Short and long columns, Radius of gyration, Buckling load, Assumptions, Derivation of Euler's Buckling load for different end conditions, Limitations of Euler's theory, Rankine's formula. Numerical problems.	**04 Hrs**

PART – B	
MECHANICS OF MATERIALS LABORATORY	
Section I	**12 Hrs**
1. Hardness Tests (Brinell, Rockwell, Vicker)	
2. Tension test on Mild steel and HYSD (High Yield Strength Deformed) bars	
3. Compression test of Mild Steel, HYSD, Cast iron.	
4. Torsion test on Mild Steel circular sections.	
5. Bending Test on Wood Under two point loading.	
6. Shear Test on Mild steel.	
7. Impact test on Mild Steel (Charpy & Izod)	
8. Wear Test using Pin on disc Tribometer.	
Section – II (Non destructive testing)	**4 Hrs**
1. Magnetic Particle Test	
2. Ultrasonic Test	
3. Dye Penetrant Test	
4. Eddy current inspection for metals	

Course Outcomes: After completing the course, the students will be able to	
1	Identify the different engineering materials, describe their properties and predict their

	behavior under different types of loading.
2	Compute the stresses, strains, moments, deflections, etc. and derive the expressions used from the fundamentals.
3	Choose materials, sizes and sections for various applications such as beams, shafts, pressure vessels, columns, etc. and justify their decision.
4	Design the testing methods and predict the mechanical properties by destructive and non-destructive approaches.

Reference Books	
1.	S.S. Bhavikatti, Strength of Materials, Vikas Publications House Pvt. Ltd. New Delhi, 2012, ISBN 9788125927914
2.	Timoshenko and Young "Elements of Strength of Materials", Affliated East-West Press, 1976 Edition, ISBN-10: 0442085478, ISBN-13: 978-0442085476.
3.	F.P.Beer and R.Johnston, "Mechanics of Materials", McGraw-Hill Publishers, 2006 ISBN 9780073529387
4.	S.Ramamrutham, R.Narayanan, "Strength of Materials", Dhanapath Rai Publishing Company, New Delhi, 2012, ISBN: 818743354X

Continuous Internal Evaluation (CIE)				
(Theory – 100 Marks)		**(Laboratory- 50 Marks)**		**Total (150)**
Evaluation method	**Course with assignment**			
Quiz -1	10	Performance of the student in the laboratory, every week	40	
Test -1	30			
Quiz -2	10			
Quiz -3	10	Test at the end of the semester	10	
Test -2	30			
Assignments	10			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A **Objective type questions**	**20**	**Experiment Conduction with proper results**	40	
Part –B There should be five questions from five units. Each question should be for maximum of 16 Marks. The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice.	**80**	**Viva**	10	

Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.					
Total	**100**	**Total**	**50**	**150**	

	What		**To whom**	**Frequency of conduction**	**Max Marks**	**Evidence**	**Contribution to Course Outcome**	
Direct Assessment Methods	CIE	Quiz	Students	Three	30	Answer Scripts	80 %	100 % 90 %
		Test		Two	60/50			
		Assignment/Self-study		2 phases	10/20	Reports / Record Books		
		Laboratory		Weekly	50			
	SEE	Semester End Examination		Consisting of Part-A and Part-B	100	Answer Scripts	20 %	
		Semester End Laboratory		End of every semester laboratory	50			
Indirect Assessment methods	Course End Survey		Students	End of course		Questionnaire Based on COs	10%	

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**L**	**H**	**M**									
CO2			**H**									
CO3		**M**			**H**					**L**		
CO4			**H**						**M**			

Low-1 Medium-2 High-3

MEASUREMENTS AND METROLOGY		
Course Code: 16IM35		**CIE Marks: 100 + 50**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks: 100 + 50**
Credits: 05		**SEE Duration: 03 + 03 Hrs**
Course Learning Objectives: The students will be able to		
1	Explain the concepts of measurement and gauging instruments.	
2	Define the relevance of various measurement systems & standards with regards to	

	practical applications.
3	Apply the principles of metrology and measurements in manufacturing industries.

UNIT-I	
CONCEPT OF MEASUREMENTS General concept – Generalised measurement system-Units and standards-measuring instruments- sensitivity, readability, range of accuracy, precision-static and dynamic response-repeatability-systematic and random errors-correction, calibration, interchange ability.	**07 Hrs**
UNIT-II	
LINEAR AND ANGULAR MEASUREMENTS Definition of metrology-Linear measuring instruments: Vernier, micrometer, interval measurement, Slip gauges and classification, interferometery, optical flats, limit gauges- Comparators: Mechanical, pneumatic and electrical types, applications. Angular measurements:-Sine bar, optical bevel protractor, angle Decker – Taper measurements,	**06 Hrs**
UNIT-III	
FORM MEASUREMENTS Measurement of screw threads-Thread gauges, floating carriage micrometer-measurement of gears-tooth thickness-constant chord and base tangent method-Gleason gear testing machine – radius measurements-surface finish, straightness, flatness and roundness measurements.	**07 Hrs**
UNIT-IV	
ADVANCES IN METROLOGY Precision instruments based on laser-Principles- laser interferometer-application in linear, angular measurements and machine tool metrology Coordinate measuring machine (CMM)- Constructional features – types, applications – digital devices- computer aided inspection,3D Metrology. Introduction to MEMS Sensors and Nano Sensors, Schematic of the design of sensor, application.	**10 Hrs**
UNIT-V	
MEASUREMENT OF POWER, FLOW & TEMPERATURE RELATED PROPERTIES Force, torque, power :-mechanical, pneumatic, hydraulic and electrical type- Temperature: bimetallic strip, pressure thermometers, thermocouples, electrical resistance thermister.	**06 Hrs**

MEASUREMENTS AND METROLOGY LABORATORY
1. Measurement of angle using Sine Bar and Sine centre **2.** Measurement of Angle using Universal Bevel Protractor **3.** Measurement of straightness using Autocollimator/Laser interferometry. Gage R & R using MiniTab.

4. Determination of modulus of Elasticity of a mild steel specimen using strain gauge (Cantilever Beam) **5.** Calibration of Pressure Transducer **6.** Calibration of Thermocouple. Gage R & R using MiniTab. **7.** Calibration of Linear Variable Differential Transformer (LVDT) **8.** Programming and Simulation of Bottle-filling process using PLC. **9.** Simulate level measurement and indication of emergency shutdown feature using Lab VIEW **10.** Programming and Simulation of Automatic Material Sorting by Conveyor using PLC. **11.** Measurement of various parameters of machine tool components using VMM **12.** Demonstration on SCM/XRD/FTRI/SOM

Course Outcomes: After completing the course, the students will be able to	
1	Discuss the principles and practices of metrology in manufacturing environment and analyze uncertainty in an appropriate manner.
2	Describe the operating principles of range of widely used instrumentation techniques and illustrate how to use them in the design of measurement systems.
3	Compare the production process, the product function and the product design, and to select appropriate measurement quantities and tools for these purposes.
4	Evaluate and respond to the need for rigorous and formal metrology concepts in designing and using measurement systems

Reference Books	
1.	Jain R.K., Engineering Metrology, Khanna Publishers, 1994,17th edition, ISBN: 71-7409-024-x
2.	Beckwith T.G, and N. Lewis Buck, Mechanical Measurements, Addison Wesley, 1991,5th edition, ISBN: 81-7808-055-9
3.	A.K.Sawhney,Electrical and electronic measurements and instrumentation,Dhanpat Rai and Sons,18th Edition,2008,ISBN 8177000160
4.	Stephen Beeby,MEMS Mechanical sensors,Artech House,2004,ISBN 1-58053-536-4

Continuous Internal Evaluation (CIE)				
(Theory – 100 Marks)		**(Laboratory- 50 Marks)**		**Total (150)**
Evaluation method	**Course with assignment**			
Quiz -1	10	Performance of the student in the laboratory, every week	40	
Test -1	25			
Quiz -2	10			
Test -2	25	Test at the end of the semester	10	
Quiz -3	10			
Self Study	20			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)				
Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A	**20**	**Experiment**		

Objective type questions		**Conduction with proper results**	40	
Part –B There should be five questions from five units. Each question should be for maximum of 16 Marks. The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**	**Viva**	10	
Total	**100**	**Total**	**50**	**150**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	H	L										
CO2		L	M								L	
CO3		M		H		L						
CO4	L	L	L									

Low-1 Medium-2 High-3

MANUFACTURING PROCESSES		
Course Code: 16IM36		**CIE Marks: 100 + 50**
Hrs/Week: L:T:P:S: 3:0:2:4		**SEE Marks: 100 + 50**
Credits: 05		**SEE Duration: 03 + 03 Hrs**
Course Learning Objectives: The students will be able to		
1	Develop the concepts related to forming & welding processes and practices.	
2	Explain the methodologies and stages involved in primary manufacturing processes.	
3	Define cutting parameters influencing metal cutting.	
4	Explain the methodologies and stages involved in secondary manufacturing processes	

UNIT-I	
Introduction: - Production and assembly processes, classification of production processes, selection of a process for production. Recyclability issues, Maintenance of various equipments. Metal Casting Process: Casting terminology, sand mould making procedure. Pattern: Pattern allowances, core prints, pattern materials, types of patterns, pattern color code. Molding Materials & Core Making: Molding sand composition, testing sand properties, sand preparation, molding sand properties, molding machines, types of cores, core prints, chaplets, metalostatic forces. Gating system Design: Elements of gating system, gates, pouring time, choke area, sprue, gating ratios, Caine's method for riser design.	**07 Hrs**

UNIT-II	
Metal forming processes: Hot working & cold working, principle of rolling & applications, forging operations Metal fabrication Processes: classification, principles of resistance welding, resistance spot welding, resistance seam welding, projection welding, flash welding, Defects in welding.	**07 Hrs**
UNIT-III	
Theory of metal cutting: Single point tool nomenclature, geometry, orthogonal & oblique cutting, mechanism of chip formation, types of chips, Merchants analysis, shear angle relationship. Tool wear & tool failure effects of cutting parameters, Tool life criteria, Taylor's tool life equation, problems on Merchants analysis & tool life evaluation Cutting tool materials: Desired properties, types of cutting tool materials- HSS carbides, coated carbides, ceramics. Cutting fluids- properties, types & selection. Machinability, factors affecting machinability.	**06 Hrs**
UNIT-IV	
Production lathes: Capstan & turret lathes-constructional features, tool & work holding devices, tool layout. Drilling machines: Classification, constructional features. Types of drill, drill bit nomenclature, geometry of twist drill. Drilling & related operations. Problems on calculating the machining time.	**07 Hrs**
UNIT-V	
Milling machines: Classification, constructional features. Milling cutters & nomenclatures. Milling operations - up milling & down milling concepts. Indexing: Purpose of indexing, indexing methods. Problems on indexing. Grinding machines: Types of Abrasives, Bonding process, classification, constructional features of surface, cylindrical & centre less grinding machines & operations.	**07 Hrs**

MANUFACTURING PROCESS LABORATORY **Part – I - Experiments on Foundry & Sand testing**	
1. Testing of Moulding sand and Core sand Preparation of specimen and conduction of the following tests: a) Compression/ Shear /Tensile tests b) Permeability test c) Grain fineness test d) Clay content test 2. Preparation of moulds - two box method: using split pattern. Match plate pattern & Cores.	
Part – II - Experiments on secondary manufacturing processes	
1.	Preparation of models involving the following lathe operations: Plain Turning, Taper Turning, Step Turning, Thread Cutting, Facing, Knurling, and Eccentric Turning.
2.	Cutting of gear teeth using milling machine
3.	Demonstration of surface grinding.
4.	Demonstration of CNC turning machine.

Course Outcomes: After completing the course, the students will be able to	
1	Explain the basic principles and methodology of various manufacturing processes that are used for the production of mechanical parts and products.
2	Compare and contrast the advantages and limitations of different manufacturing processes
3	Solve the problems on processing time and economics of processing of material with respect to a manufacturing process.
4	Apply the design concept of various manufacturing processes when a specific product has to be manufactured.

Reference Books	
1.	P.N. Rao, Manufacturing Technology: Foundry Forming and Welding, TMH, 2nd Edition, 1998, ISBN: 0-07-463180-2.
2.	J.P.Kaushish, Manufacturing Processes, PHI Learning Pvt.Ltd, 2nd Edition, 2010, ISBN: 978-81-203-4082-4
3.	G. Boothroyd, Fundamentals of Metal Machining & Machine Tools, Mc Graw Hill, 2004, ISBN: 978-1-5-7442659 -3.
4.	HMT, Production Technology, Tata McGraw Hill, 2004, ISBN: 0-07-096443-2.

Continuous Internal Evaluation (CIE)

(Theory – 100 Marks)		**(Laboratory- 50 Marks)**		**Total (150)**
Evaluation method	**Course with assignment**			
Quiz -1	10	Performance of the student in the laboratory, every week	40	
Test -1	25			
Quiz -2	10			
Test -2	25	Test at the end of the semester	10	
Quiz -3	10			
Self Study	20			
Total	**100**	**Total**	**50**	**150**

Semester End Evaluation (SEE)

Theory (100 Marks)		**Laboratory(50 Marks)**		**Total (150)**
Part- –A **Objective type questions**	**20**	**Experiment** **Conduction with proper results**	40	
Part –B There should be five questions from five units. Each question should be for maximum of 16 Marks. The **UNIT-1, UNIT-4 and UNIT-5** should not have any choice. The **UNIT-2 and UNIT-3** should have an internal choice. Both the questions should be of the same complexity in terms of COs and Bloom's taxonomy level.	**80**	**Viva**	10	

Total	100	Total	50	150

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	M											
CO2		M										L
CO3		H	L									
CO4		M	H	L	L							L

Low-1 Medium-2 High-3

BRIDGE COURSE MATHEMATICS		
Course Code: 16DMA37		**CIE Marks: 100**
Hrs/Week: L:T:P:S: 2:0:0:0		**SEE Marks: 100**
Audit Course		**SEE Duration: 3Hrs**
Course Learning Objectives: The students will be able to		
1	Acquire knowledge of multivariate functions, types of derivatives involved with these functions, Jacobian as transformation factor and applications.	
2	Enhance the knowledge level to visualize integrals in higher dimensional geometry, possible representation and evaluation of geometrical and physical quantities in terms of multiple integrals.	
3	Recognize and model differential equations, apply analytic techniques to compute solution for engineering problems.	
4	Acquire concepts of vector function, vector field, differential calculus of vector functions in Cartesian coordinates.	
5	Finding the approximate solutions using numerical methods, for problems which do not have analytical solutions.	

UNIT-I	
DIFFERENTIAL CALCULUS Taylor and Maclaurin's series for function of single variable. Introduction-partial derivatives, simple problems. Total derivative, Composite functions, Jacobians- simple problems.	**06 Hrs**
UNIT-II	
MULTIPLE INTEGRALS Evaluation of double and triple integrals – direct problems, change of order in double integral, change of variables to polar, cylindrical and spherical coordinate systems.	**06 Hrs**
UNIT-III	
DIFFERENTIAL EQUATIONS Higher order linear differential equations with constant coefficients, Complementary function and Particular integral, problems. Equations with variable coefficients – Cauchy and Legendre differential equations, problems.	**06 Hrs**
UNIT-IV	
VECTOR DIFFERENTIATION Introduction, simple problems in terms of velocity and acceleration. Concepts of Gradient, Divergence- solenoidal vector function, Curl- irrotational vector function	**06 Hrs**

and Laplacian, simple problems.	
UNIT-V	
NUMERICAL METHODS Algebraic and transcendental equations – Regula-Falsi method, Newton-Raphson method. Ordinary Differential Equations – Taylor's, modified Euler's and 4^{th} order Runge-Kutta methods. Numerical Integration – Simpson's $1/3^{rd}$, $3/8^{th}$ and Weddle's rules.	**06 Hrs**

Course Outcomes: After completing the course, the students will be able to	
1	Understand the significance of fundamental concepts of Mathematics in various Engineering problems.
2	Interpret the concept of differentiation, integration and differential equations in Engineering and real life problems
3	Apply effectively appropriate quantitative tools and logical modes of thinking to analyze for solving Engineering problems.
4	Justify the application of various Mathematical models and broaden the problem solving skills in a wide range of intellectual domains.

Reference Books	
1.	
2.	
3.	
4.	