NANDHA ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE, New Delhi)
Erode-638 052, Tamilnadu, India, Phone: 04294 – 225585

Curriculum and Syllabus

for

M.E. Engineering Design [R17]

[CHOICE BASED CREDIT SYSTEM]

(This Curriculum and Syllabi are applicable to Students admitted from the academic year 2017-2018 onwards)

SEPTEMBER 2021

NANDHA ENGINEERING COLLEGE
(Autonomous Institution Affiliated to Anna University, Chennai)
DEPARTMENT OF MECHANICAL ENGINEERING M.E. ENGINEERING DESIGN
(For the students admitted during 2017-2018 and onwards)

Programme Educational Objectives (PEOs) :

PEO1: Graduates will be successful practitioners in solving industry's technological problems
PEO2: Graduates will be entrepreneurs and contribute to the economic growth of the country
PEO3: Graduates will pursue higher studies in engineering or management successfully
PEO4: Graduates will make successful career paths in teaching / industry / research
PEO5: Graduates will function in their career with professional and ethical responsibilities

PROGRAM OUTCOMES:
At the end of a programme a students will be able to demonstrate ability to

a - l	GRADUATE ATTRIBUTEs	PO No.	PROGRAMME OUTCOMEs
a	Engineering Knowledge	PO1	an ability to apply knowledge of mathematics, science and engineering
b	Problem Analysis	PO2	an ability to design and conduct experiments, as well as to analyze and interpret data
c	Design and Development of Solutions	PO3	an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, safety, manufacturability and sustainability
d	Investigation of Complex Problems	PO4	an ability to function on multidisciplinary teams to solve complex problems
e	Modern Tool Usage	PO5	an ability to use the techniques, skills and modern engineering tools necessary for engineering practice
f	The Engineer and Society	PO6	an ability to infer societal, health, safety, legal & cultural issues and consequent responsibilities relevant to the professional engineering practice
g	Environment and Sustainability	PO7	an ability to explain, compare and summarize the impact of engineering solutions for sustainable development with societal and environmental perspective
h	Ethics	PO8	an understanding of professional and ethical responsibility
i	Individual and Team Work.	PO9	an ability to function effectively as an individual / team in different environments
j	Communication	PO10	an ability to communicate effectively
k	Project Management and Finance	PO11	an ability to apply knowledge of engineering and management principles to the projects
l	Lifelong Learning	PO12	an ability to recognize the need for life-long learning

NANDHA ENGINEERING COLLEGE (AUTONOMOUS) , ERODE-52
REGULATIONS -2017
M.E. ENGINEERING DESIGN
CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABI

SEMESTER - I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1	17EDA01	Advanced Numerical Methods	FC	NIL	4	3	2	0	4
2	17EDA02	Concepts of Engineering Design	FC	NIL	3	3	0	0	3
3	17EDB01	Mechanical Vibrations	PC	NIL	4	4	0	0	4
4	17EDB02	Failure Analysis and Design	PC	NIL	3	3	0	0	3
5	17EDB03	Computer Applications in Design	PC	NIL	3	3	0	0	3
6	17EDB04	Design for Manufacture, Assembly and Environments	PC	NIL	3	3	0	0	3
PRACTICALS									
7	17EDP01	Computer Aided Modeling Lab	PC	NIL	4	0	0	4	2
				TOTAL	**24**	**19**	**2**	**4**	**22**

SEMESTER: II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1	17EDB05	Advanced Finite Element Analysis	PC	17EDA01	4	4	0	0	4
2	17EDB06	Mechanisms Design and Simulation	PC	NIL	4	4	0	0	4
3	17EDB07	Integrated Mechanical Design	PC	17EDA01	4	4	0	0	4
4	E01	Elective I	PE	Ref. PE	3	3	0	0	3
5	E02	Elective II	PE	Ref. PE	3	3	0	0	3
6	E03	Elective III	PE/OE	Ref. PE	3	3	0	0	3
PRACTICALS									
7	17EDP02	Analysis and Simulation Lab	PC	17EDP01	4	0	0	4	2
8	17EDE01	Technical Seminar	EEC	NIL	2	0	0	2	1
				TOTAL	**27**	**21**	**0**	**6**	**24**

SEMESTER: III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1	E 04	Elective IV	PE	Ref. PE	3	3	0	0	3
2	E 05	Elective V	PE	Ref. PE	3	3	0	0	3
3	E 06	Elective VI	PE	Ref. PE	3	3	0	0	3
PRACTICALS									
4	17EDE02	Project Work Phase - I	EEC	NIL	12	0	0	12	6
5	17EDE03	Industrial Training	EEC	NIL	4	0	0	4	1
				TOTAL	**25**	**9**	**0**	**16**	**16**

SEMESTER: IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PREREQUISITE	CONTACT PERIODS	L	T	P	C
THEORY									
1	17EDE04	Project Work Phase - II	EEC	17EDE02	24	0	0	24	12
				TOTAL	**24**	**0**	**0**	**24**	**12**

Total credits to be earned for the award of degree = 22+24+16+12 = 74

FOUNDATION COURSES (FC)

SL. NO.	COURSE CODE	COURSE TITLE	PREREQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	17EDA01	Advanced Numerical Methods	NIL	4	3	2	0	4	I
2	17EDA02	Concepts of Engineering Design	NIL	3	3	0	0	3	I

PROFESSIONAL CORE (PC)

SL. NO.	COURSE CODE	COURSE TITLE	PREREQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	17EDB01	Mechanical Vibrations	NIL	4	4	0	0	4	I
2	17EDB02	Failure Analysis and Design	NIL	3	3	0	0	3	I
3	17EDB03	Computer Applications in Design	NIL	3	3	0	0	3	I
4	17EDB04	Design for Manufacture, Assembly and Environments	NIL	3	3	0	0	3	I
5	17EDP01	Computer Aided Modeling Lab	NIL	4	0	0	4	2	I
6	17EDB05	Advanced Finite Element Analysis	17EDA01	4	4	0	0	4	II
7	17EDB06	Mechanisms Design and simulation	NIL	4	4	0	0	4	II
8	17EDB07	Integrated Mechanical Design	17EDA01	4	4	0	0	4	II
9	17EDP02	Analysis and Simulation Lab	17EDP01	4	0	0	4	2	II

PROFESSIONAL ELECTIVES (PE)

SL. NO.	COURSE CODE	COURSE TITLE	PREREQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	17EDX01	Design of Fluid Power systems	NIL	3	3	0	0	3	II
2	17EDX02	Composite Materials and Mechanics	NIL	3	3	0	0	3	II
3	17EDX03	Mechanical Behavior of Materials	NIL	3	3	0	0	3	II
4	17EDX04	Maintenance Engineering	NIL	3	3	0	0	3	II
5	17EDX05	Design of Material Handling Equipment	NIL	3	3	0	0	3	II
6	17EDX06	Experimental Stress Analysis	NIL	3	3	0	0	3	II
7	17EDX07	Advanced Tool Design	17EDB02	3	3	0	0	3	II
8	17EDX08	Biomechanics	NIL	3	3	0	0	3	II
9	17EDX09	Mechatronics in Manufacturing Systems	NIL	3	3	0	0	3	II

10	17EDX10	Bearing Design and Rotor Dynamics	NIL	3	3	0	0	3	II
11	17EDX11	Additive Manufacturing	NIL	3	3	0	0	3	II
12	17EDX12	Advanced Metal Forming Techniques	NIL	3	3	0	0	3	II
13	17EDX13	Optimization Techniques in Design	17EDA01	3	3	0	0	3	III
14	17EDX14	Computational Fluid Dynamics	17EDA01, 17EDB05	3	3	0	0	3	III
15	17EDX15	Design of Pressure Vessel and Piping	NIL	3	3	0	0	3	III
16	17EDX16	Design of Heat Exchangers	NIL	3	3	0	0	3	III
17	17EDX17	Productivity Management and Re-Engineering	17EDA02	3	3	0	0	3	III
18	17EDX18	Design for Internet of Things	NIL	3	3	0	0	3	III
19	17EDX19	Design for Six Sigma	NIL	3	3	0	0	3	III
20	17EDX20	Advanced Strength of Materials	17EDB01	3	3	0	0	3	III
21	17EDX21	Tribology in Design	NIL	3	3	0	0	3	III
22	17EDX22	Nanomaterials and Nano Technology	NIL	3	3	0	0	3	III
23	17EDX23	Micro Electro Mechanical Systems	NIL	3	3	0	0	3	III
24	17EDX24	Surface Engineering	NIL	3	3	0	0	3	III
25	17EDX25	Engineering Fracture Mechanics	17EDB02	3	3	0	0	3	III
26	17EDX26	Industrial Robotics and Expert systems	NIL	3	3	0	0	3	III
27	17EDX27	Product Lifecycle Management	NIL	3	3	0	0	3	III
28	17EDX28	Quality Concepts in Design	NIL	3	3	0	0	3	III

OPEN ELECTIVES (OE)

SL. NO.	COURSE CODE	COURSE TITLE	PREREQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	17BAZ01	Research Methodology	OE	-	3	0	0	3	II
2	17CPZ01	Machine Vision	OE	-	3	0	0	3	II

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	PREREQUISITE	CONTACT PERIODS	L	T	P	C	P.S
1	17EDE01	Technical Seminar	NIL	2	0	0	2	1	II
2	17EDE02	Project Work Phase - I	NIL	12	0	0	12	6	III
3	17EDE03	Industrial Training	NIL	4	0	0	4	1	III
4	17EDE04	Project Work Phase - II	17EDE02	24	0	0	24	12	IV

SL. No.	SUBJECT AREA	SUMMARY				
		CREDITS TOTAL				
		I	II	III	IV	TOTAL
1	FC	7	-	-	-	7
2	PC	15	14	-	-	29
3	PE	-	9	9	-	18
4	EEC		1	7	12	20
TOTAL		22	24	16	12	74

17EDA01 ADVANCED NUMERICAL METHODS					
		L	T	P	C
		3	2	0	4
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES :					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To get familiarized with the numerical methods which are necessary to solve numerically the problems	**1.1**	Derive appropriate numerical methods to solve algebraic and transcendental equations.		**a,b,d,k,l**
2.0	To develop appropriate numerical methods to solve an ordinary differential equation	**2.1**	Solve an ordinary differential equation using an appropriate numerical method		**a,b,d,f,l**
3.0	To develop appropriate numerical methods to solve a partial differential equation	**3.1**	Solve a partial differential equation using an appropriate numerical method		**a,b,c,d,k,l**
4.0	Understand the finite difference methods and how to apply them to engineering problems.	**4.1**	Familiar with the use of finite difference methods for boundary value problem		**a,b,d,f,l**
5.0	Demonstrate understanding and implementation of numerical solution algorithms applied to finite element.	**5.1**	Solve a partial differential equation using an appropriate numerical method under finite element method.		**a,b,c,d,k,l**

UNIT I : ALGEBRAIC EQUATIONS	**(9+6)**
Systems of linear equations : Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system - Jacobi, Gauss Seidel , SOR iteration methods	
UNIT II : ORDINARY DIFFERENTIAL EQUATIONS	**(9+6)**
RungeKutta Methods for system of IVPs, numerical stability, Adams - Bashforth multistep method, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.	
UNIT III : FDM FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATION	**(9+6)**
Parabolic equations : explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions - Two dimensional parabolic equations - ADI method; First order hyperbolic equations - method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines	
UNIT IV : FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS	**(9+6)**
Finite difference expressions for partial derivatives - Laplace's equation - Liebmann method - Derivative boundary conditions - Poisson equation.	
UNIT V : FINITE ELEMENT METHOD	**(9+6)**
Partial differential equations - Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.	
TOTAL : L : 45 +T: 30 = 75 PERIODS	

REFERENCES:

1. Saumyen Guha and Rajesh Srivastava, “Numerical methods for engineering and science”, Oxford higher education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., “Numerical analysis – theory and applications”, Cengage Learning, India Edition, New Delhi, 2009
3. Morton K.W. and Mayers D.F., “Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2002.
4. Curtis F Gerald and Patrick O Wheatley, “Applied Numerical Analysis”, Pearson Education, New Delhi, 2011.
5. Ward Cheney and David Kincaid, “Numerical Mathematics and Computing”, Cengage Learning, New Delhi, 2013

17EDA02 CONCEPTS OF ENGINEERING DESIGN					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the fundamentals of design process for products	**1.1**	Apply the design concepts in various industrial products based on customer requirements.	**a, f, l**	
2.0	To impart the importance of design in today's context of global competition, environmental awareness and customer oriented market.	**2.1**	Utilize the statistical tools in monitoring the performance of products.	**a,b,c,d,e,i,k,l**	
3.0	To understand the various design methods of engineering design	**3.1**	Be familiar with the design concepts to improve the reliability and productivity.	**a,b,c,k,l**	
4.0	To understand the selection of proper materials	**4.1**	Apply the material selection process and design for manufacture.	**a,b,c,k,l**	
5.0	To impart the basic concepts and various aspects of design using simple examples and case studies.	**5.1**	Gain knowledge about the failure mode effect analysis and green design process.	**a,c,e,f,i,k,l**	

UNIT I : DESIGN FUNDAMENTALS	**(9)**
Importance of design - Design process - Considerations of good design - Morphology of design - Organization for design – Designing to codes and standards - Product and process cycles - Technological innovation.	
UNIT II : CUSTOMER ORIENTED DESIGN	**(9)**
Identification of customer needs - Customer requirements - Bench marking quality function deployment - Product design specifications - Human factors in design - Ergonomics and aesthetics - Contracts - Product liability - Protecting intellectual property - Legal and ethical domains -Codes of ethics -Ethical conflicts	
UNIT III : DESIGN METHODS	**(9)**
Creativity and problem solving - Creative thinking methods - Theory of inventive problem solving (TRIZ) - Decision making - Embodiment design - Product architecture - Configuration design - Parametric design - Role of models in design - Rapid prototyping - Finite element analysis - Optimization.	
UNIT IV : MATERIAL SELECTION PROCESSING AND DESIGN	**(9)**
Material selection process - Economics -Weighted property index - Classification of manufacturing process - Design for manufacture - Design for assembly - Designing for castings, Forging, Metal Forming, Machining and Welding - Residual stresses.	
UNIT V : PROBABILITY CONCEPTS IN DESIGN & GREEN DESIGN PROCESS	**(9)**
Probability - Distributions - Test of hypothesis - Design of experiments - Reliability theory - Design for reliability - Robust design - Failure mode effect analysis. Design for environment - Green design process: Material life cycle, embodied energy, carbon footprint, green design in industry, sustainability.	
TOTAL : L: 45 = 45 PERIODS	

REFERENCES:

1. Dieter George E., "Engineering Design - A Materials and Processing Approach", 4th ed., Tata McGraw Hill, 2013.
2. Pahl, G, and Beitz, W., "Engineering Design", 3rd ed., Springer – Verlag, NY. 2007.
3. Robert C Juvinall, "Fundamentals of Machine Component Design", Wiley, 2011.
4. Suh, N.P., "The Principles of Design", Oxford University Press, NY.1990.
5. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development" , 4th ed., McGraw Hill, 2009

17EDB01 MECHANICAL VIBRATIONS					
		L	T	P	C
		4	0	0	4
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the fundamentals of vibration and its practical applications	**1.1**	Understand the basics of vibration and its importance in engineering field.	**a,l**	
2.0	To understand the working principle and operations of various vibration measuring instruments	**2.1**	Various vibration measuring instruments, vibration control and analysis techniques.	**a,e,k,l**	
3.0	To study the multi degree freedom system and continuous system	**3.1**	Familiar with the Multi-degree freedom system and continuous system.	**a,l**	
4.0	To understand the various vibration control strategies	**4.1**	Apply the vibration control system	**a,b,e,k,l**	
5.0	To provide knowledge on experimental methods in vibration analysis.	**5.1**	Gain knowledge about the experimental methods in vibration analysis	**a,b,c,d,e,k,l**	

UNIT I : FUNDAMENTALS OF VIBRATION	**(12)**
Introduction - Sources of vibration - Mathematical models - Displacement, velocity and acceleration - Review of single degree freedom systems - Vibration isolation vibrometers and accelerometers - Response to arbitrary and non - harmonic excitations - Transient vibration - Impulse loads - Critical speed of Shaft - Rotor systems.	
UNIT II : TWO DEGREE FREEDOM SYSTEM	**(12)**
Introduction - Free vibration of undamped and damped -Forced vibration with harmonic excitation system -Coordinate couplings and principal coordinates	
UNIT III : MULTI - DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM	**(12)**
Multi degree freedom system - Influence coefficients and stiffness coefficients - Flexibility matrix and stiffness matrix - Eigen values and Eigen vectors - Matrix iteration method - Approximate methods : Dunkerley, Rayleigh's, and Holzer Method - Geared systems - Eigen values & Eigen vectors for large system of equations using sub space, Lanczos method - Continuous system : Vibration of string, Shafts and Beams	
UNIT IV : VIBRATION CONTROL	**(12)**
Specification of vibration limits -Vibration severity standards - Vibration as condition monitoring tool - Vibration isolation methods - Dynamic vibration absorber, Torsional and pendulum type absorber -Damped vibration absorbers - Static and dynamic balancing - Balancing machines - Field balancing - Vibration control by design modification - Active vibration control	
UNIT V : EXPERIMENTAL METHODS IN VIBRATION ANALYSIS	**(12)**
Vibration analysis overview - Experimental methods in vibration analysis - Vibration measuring instruments - Selection of sensors - Accelerometer mountings - Vibration exciters - Mechanical,Hydraulic,Electromagnetic and Electrodynamics - Frequency measuring instruments - System identification from frequency response - Testing for resonance and mode shapes	
TOTAL : L : 60 = 60 PERIODS	
REFERENCES: 1. Rao, S.S., "Mechanical Vibrations," Prentice Hall, 2011. 2. Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishers and Distributors,New Delhi, 1990	

3. Ramamurti. V, “Mechanical Vibration Practice with Basic Theory”, Narosa, New Delhi, 2000.
4. S. Graham Kelly & Shashidar K. Kudari, “Mechanical Vibrations”, Tata McGraw –Hill Publishing Com. Ltd New Delhi,2007.

17EDB02 FAILURE ANALYSIS AND DESIGN					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To impart knowledge about various modes of failure this leads to materials and design.	**1.1**	Understand the various modes of failure and material behavior in fracture loading.	**a,b,c,d,e,f,i,k,l**	
2.0	To learn about large variety of fracture mechanisms and fracture modes associated with failure.	**2.1**	Demonstrate fracture mechanisms and fracture, creep, fatigue, corrosion and wear failures.	**a,b,c,d,e,f,i,k,l**	
3.0	To provide an exposure to the students on statistical nature of fatigue and fatigue tests	**3.1**	Illustrate the type's fatigue analyzing process.	**a,b,c,d,e,f,i,k,l**	
4.0	To provide fundamental knowledge of corrosion and environmentally-assisted cracking.	**4.1**	Implement of failure analysis principles in innovative applications.	**a,b,c,d,e,f,i,k,l**	
5.0	To study about industrial application of failure analysis tools	**5.1**	Explain the failure analysis tools.	**a,b,c,d,e,f,i,k,l**	

UNIT I : MATERIALS AND DESIGN PROCESS	**(9)**
Factors affecting the behavior of materials in components, effect of component geometry and shape factors, design for static strength, stiffness, designing with high strength and low toughness materials, material selection process, introduction to stress, two dimensional and three dimensional state of stress, Mohr's circle two and three dimensions, hydrostatic stress, von-Mises, maximum shear stress (Tresca), octahedral shear stress.	
UNIT II : FRACTURE MECHANICS	**(9)**
Ductile fracture, brittle fracture, cleavage-fractography, ductile to brittle transition, factors affecting ductile to brittle transition, fracture mechanics approach to design-energy criterion, stress intensity approach, time dependent crack growth and damage - Linear Elastic Fracture Mechanics: Griffiththeory, energy release rate, Instability and R-curve, stress analysis of cracks-stress intensity factor, Crack growth instability analysis.	
UNIT III : FATIGUE	**(9)**
Statistical nature of fatigue, signal-noise curve, low cycle fatigue, strain life equations, structural feature of fatigue, fatigue crack propagation, effect of stress concentration, size, surface properties, metallurgical variables on fatigue, case studies, designing against fatigue, detail design, improvements after failure and service, fatigue of bolts, welded and adhesive joints. Fatigue Tests-Purpose, specimen, fatigue test procedures, evaluation of fatigue test results, crack growth measurement. Creep, stress rupture, elevated temperature fatigue, super plasticity.	
UNIT IV : CORROSION AND WEAR FAILURES	**(9)**
Types of corrosion, Factors influencing corrosion failures, analysis of corrosion failures, stress corrosion cracking - sources, characteristics of stress corrosion cracking, procedure of analyzing stress corrosion cracking, various types of hydrogen damage failures, corrective and preventiveaction. Types of wear, lubricated and non – lubricated wear, wear on different materials, different methods of wear measurement. Role of friction on wear, analysis of wear failures, wear tests -ferrography.	
UNIT V : FAILURE ANALYSIS TOOLS	**(9)**
Reliability concept and hazard function, application of Poisson, exponential and Weibull distribution for reliability, bathtub curve, parallel and series system, failure mode effect analysis - definition-Design, types, process, industrial case studies / Projects.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Yiannis Papadopoulos, Engineering failure analysis and design optimization with HiPHOPS" Engineering Failure Analysis, Volume 18, Issue 2, pp 590–608, March 2011.
2. F. Rui, Martins, Failure analysis of bilge keels and its design improvement, Engineering Failure Analysis, Volume 27, pp 232–249, January 2013.
3. T. L. Anderson, Fracture Mechanics: Fundamentals and Applications, CRC Press, 2005.
4. F.Michael and Ashby, Material Selection in Mechanical Design, Butterworth Heinemann, 2004.
5. ASM Metals Handbook, Failure Analysis and Prevention, ASM Metals Park, Ohio, USA, Vol.10, 2002.
6. J.E. Shigley and Mische, Mechanical Engineering Design, McGraw Hill, 2000.

17EDB03 COMPUTER APPLICATIONS IN DESIGN					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To develop the modeling skills using computer graphic techniques.	**1.1**	Integrate CAD and gain the advantages of lead time reduction	**a,l**	
2.0	To impart knowledge on CAD software and data exchange standards.	**2.1**	Create CAD packages for various products which include parts, assembly etc.,	**a,e,i,k,l**	
3.0	To study the applications of nurbs and solid modeling	**3.1**	Understand the meaning of CAD and transfer of product data in various software.	**a,c,d,e,i,l**	
4.0	To gain knowledge on visual realism and computer animation.	**4.1**	Describe the types nurbs and solid modeling	**a,e,i,l**	
5.0	To provide knowledge on assembly modeling and tolerance analysis	**5.1**	Demonstrate the knowledge of assembly modeling and tolerance analysis	**a,c,d,e,l**	

UNIT I : INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS	**(9)**
Output primitives (points, lines, curves etc.) 2D & 3D transformation (Translation, scaling, rotations) windowing - view ports - clipping transformation Open GL Data Exchange standards- IGES, STEP etc. - Communication standards.	
UNIT II : CURVES AND SURFACE MODELING	**(9)**
Representation of curves - Bezier curves- cubic spline curve - B-Spline curves - Rational curves - Curve manipulations Representation of surface modeling techniques - Analytical surfaces : Plane surface, ruled surface, surface of revolution and tabulated cylinder - synthetic surfaces: Hermite bicubic surface- Bezier surface and B-Spline surface - surface manipulation.	
UNIT III : NURBS AND SOLID MODELING	**(9)**
NURBS - Basics - curves, lines, arcs, circle and bi linear surface Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations constructive solid geometry comparison of representations - user inter face for solid modeling.	
UNIT IV : VISUAL REALISM	**(9)**
Hidden Line - Surface-solid removal algorithms shading - coloring. Introduction to parametric and variational geometry based software sand the in principles creation of prismatic and lofted parts using the sepackages.	
UNIT V : ASSEMBLY OF PARTS	**(9)**
Assembly modeling - interferences of positions and orientation - tolerances analysis - mass property calculations-mechanism simulation	
TOTAL : L: 45 = 45 PERIODS	
REFERENCES: 1. Ibrahim Zeid, "Mastering CAD/CAM", 2nd ed., McGraw Hill, International Edition, 2006.	

2. Donald Hearn, M. Pauline Baker, “Computer Graphics”, 4th ed., Prentice Hall, Inc., 2010.
3. William M Neumann, Robert F. Sproul, “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.
4. P.Radhakrishnan, C.P.Kothandaraman, “Computer Graphics and Design”, Dhanpat Rai and Sons,1999.
5. Foley,Wan Dam, Feiner and Hughes, “Computer Graphics Principles & Practices”, Pearson Education, 2003

17EDB04 DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the principles of component design for easy manufacturing.	**1.1**	Estimate tolerances for different dimension of a product based on the selected manufacturing process	**a,c,e,f,g,k,l**	
2.0	To study the process capability, and factors influencing form design.	**2.1**	Select material for particular product based on the functional requirement.	**a,b,c,d,e,i,k,l**	
3.0	To know the machining and casting considerations for manufacturing oriented design.	**3.1**	Apply a systematic understanding of knowledge in the field of metal casting and machining.	**a,b,c,d,e,i,k,l**	
4.0	To expose the impact of design on environment to achieve eco-friendly component design	**4.1**	Select the various machining processes depends upon the materials and its applications.	**a,b,c,d,e,i,k,l**	
5.0	To provide knowledge on design for the environment methods	**5.1**	Design the components based on environmental issues.	**a,c,d,e,f,g,k,l**	

UNIT I : INTRODUCTION	**(9)**
General design principles for manufacturability - Factors influencing design -Types of problems to be solved - evaluation of customer's requirements-Systematic working plan for the designer-Possible solutions - Evaluation method - Process capability - Feature tolerances - Geometric tolerances - Assembly limits - Datum features - Tolerance stacks - Interchangeable part manufacture and selective assembly.	
UNIT II : FACTORS INFLUENCING FORM DESIGN	**(9)**
Working principle, Material, Manufacture, Design - Materials choice - Influence of basic design, mechanical loading, material, production method, size and weight on form design- form design of welded members and forgings	
UNIT III : COMPONENT DESIGN – CASTING CONSIDERATION	**(9)**
Form design of grey iron, steel, malleable iron and aluminium castings. Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores.	
UNIT IV : COMPONENT DESIGN - MACHINING CONSIDERATION	**(9)**
Design features to facilitate machining - drills - milling cutters - keyways - Dowelling procedures, counter sunk screws - Reduction of machined area - simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly. Redesign For Manufacture - Identification of uneconomical design - Modifying the design - Group technology - Computer Applications for DFMA	
UNIT V : DESIGN FOR THE ENVIRONMENT	**(9)**
Introduction - Importance of DFE - Environmental objectives - Global issues - Regional and local issues - Basic DFE methods - Design guide lines - Lifecycle assessment - Basic method - AT&T's environmentally responsible product assessment - Weighted sum assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly - Design for recyclability - Design for remanufacture - Design for energy efficiency - Design to regulations and standards.	
TOTAL : L : 45 = 45 PERIODS	
REFERENCES:	
1. Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", 3rd ed.,CRS Press, 2012.	

2. Boothroyd. G, “Design for Assembly Automation and Product Design”, 2nd ed., NewYork, Marcel Dekker, 2005
3. Bralla, “Design for Manufacture handbook”, 2nd ed., McGraw hill, 2002
4. Dickson, John. R, and Corroda Poly, “Engineering Design and Design for Manufacture and Structural Approach”, Field Stone Publisher, USA, 1995.
5. Fixel, J. “Design for the Environment”, McGraw Hill, 1996.
6. Kevien Otto and Kristin Wood, “Product Design”, Pearson Publication, 2004.
7. Harry Peck, “Designing for Manufacture”, Pitman publishing, 1983.

17EDP01 COMPUTER AIDED MODELING LAB					
		L	T	P	C
		0	0	4	2
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To develop skill on creating of 2D & 3D models, surface models using any one of modeling software.	**1.1**	Read the drawing and Interpret the data and dimensions	**a,b,c,d,e,i,k,l**	
2.0	To understand the concept of various tolerances and fits used for component design.	**2.1**	Create CAD models for various products which include parts, assembly etc.	**a,c,d,e,i,k,l**	
3.0	To understand and practice the drawings of machine components and simple assemblies using modeling packages.	**3.1**	Understand various practices like Modeling and drafting of Mechanical Components	**a,c,d,e,i,k,l**	
4.0	To impart knowledge on simulation of different mechanisms like 4-bar, slider and cam mechanisms using any one of modeling software.	**4.1**	Understand various CAD Study of Sketcher Solid modeling	**a,c,d,e,i,k,l**	
5.0	To expose the impact of simulate the physical system using a CAD model of eco-friendly component design	**5.1**	Simulate the physical system using a CAD model	**a,b,c,d,e,f,g,i,k,l**	

Study of CAD Study of Sketcher Solid modeling - Extrude, Revolve, Sweep, etc. and variational sweep, Loft, etc. **Surface modeling** - Extrude Sweep, Trim etc. and Mesh of curves, Free form etc. Feature manipulation - Copy, Edit, Pattern, Suppress, History operations etc. Assembly - Constraints, Exploded Views, Interference check
Drafting - Layouts, Standard & Sectional Views, Detailing & Plotting
Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Software Packages.

LIST OF EXPERIMENTS:

1. Modeling and Assembling of Machine Vice
2. Create an assembly model of Tailstock
3. Modeling of Connecting rod
4. Modeling of Butterfly Valve Assembly
5. Modeling of Pulley Support Assembly
6. Modeling of Fixture Assembly
7. Modeling of Shaper Tool Head Assembly
8. Surface Modeling of Piston
9. Simulation of Four bar Mechanism
10. Simulation of Slider Crank Mechanisms
11. Simulation of Spur Gear Drive.
12. Simulation of Cam & Follower

TOTAL : P: 45 = 45 PERIODS

17EDB05 ADVANCED FINITE ELEMENT ANALYSIS					
		L	T	P	C
		4	0	0	4
PREREQUISITE : 17EDA01					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the basic principles of the finite element analysis techniques and enhancing the ability to apply the tools of the analysis for solving practical problems arising in engineering design.	**1.1**	Apply finite elements technique in engineering problem solving for various applications.	**a,b,c,d,e,i,k,l**	
2.0	To create expertise in basic elements, one and two dimensional problems.	**2.1**	Derive finite element equation and to solve the real time 1D and 2Dstructural and thermal problems.	**a,b,c,d,e,i,k,l**	
3.0	To create expertise in basic elements of Isoperimetric elements problems.	**3.1**	Solve and analysis the engineering problems using isoparametric and parametric elements.	**a,b,c,d,e,i,k,l**	
4.0	To provide knowledge on structural dynamic analysis of bar and beam element	**4.1**	Estimate the solve structural dynamic analysis	**a,b,c,d,e,i,k,l**	
5.0	To study the non-linear problems and error estimates of FEM	**5.1**	Create nonlinear problems and error method	**a,b,c,d,e,i,k,l**	

UNIT I : ONE-DIMENSIONAL PROBLEMS	**(12)**
Basic concept of FEM - Weighted residual methods - Variational formulation of B.V.P - Ritz method - Finite element modeling - Element equations - Linear and quadratic shape functions - Bar and beam elements - Bars and beams of arbitrary orientation - Applications to structural heat transfer problems.	
UNIT II : TWO-DIMENSIONAL PROBLEMS	**(12)**
Poisson equation - Laplace equation - Weak form - Element matrices for triangular and rectangular elements - Evaluation of integrals - Applications - Conduction and convection heat transfer - Theory of elasticity - Plane strain - Plane stress - Axi-symmetric problems - Principle of virtual displacement.	
UNIT III : ISOPARAMETRIC ELEMENTS	**(12)**
Natural Co-ordinate Systems - Lagrangian Interpolation Polynomials - Isoparametric elements - Quadrilateral elements formulation - Jacobian matrix -Triangular elements - Rectangular elements - Serendipity elements - Numerical Integration - Gauss quadrature - Illustrative Examples.	
UNIT IV : STRUCTURAL DYNAMIC ANALYSIS	**(12)**
Dynamic equations - Consistent and lumped mass matrices - 1D bar element - Formulation of element stiffness, mass and force matrices - Example problems. Natural frequencies - 1D beam element - Formulation of element stiffness, mass matrices.	
UNIT V : NON-LINEAR PROBLEMS AND ERROR ESTIMATES	**(12)**
Introduction - Material non-linearity - Elasto Plasticity - Plasticity - Visco plasticity - Geometric non-linearity - Large displacement - Error norms and convergence rates - H-refinement with adaptivity - adaptive refinement.	
TOTAL : L : 60 = 60 PERIODS	

REFERENCES:

1. Reddy J.N., "An Introduction to the Finite Element Method", 3rd ed.,McGraw Hill, International Edition, 2005.
2. Cook, Robert Davis et al, "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 2002.
3. Logan D.L, "A First Course in the Finite Element Method", 5th ed.,Thomson Learning, 2012.
4. Chandrupatla, T. R and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Pearson Education, New Delhi, 2007.Sugarland L.J., "Applied Finite Element Analysis", 2nd ed.,John Wiley, 2010.
5. S.S.Rao, "Finite Element Analysis", 5th ed.,2002.
6. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", 6th ed., McGraw Hill International Edition, Physics Services, 2005.

17EDB06 MECHANISMS DESIGN AND SIMULATION					
		L	T	P	C
		4	0	0	4
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To develop a thorough understanding of the various mechanism designs and its simulation with ability to effectively uses the various mechanisms in real life problems.	**1.1**	Design the linkages for particular applications and analyze the velocity and acceleration of various mechanisms.	**a,b,c,d,e,i,k,l**	
2.0	To understand the layout of linkages in the assembly of a system/machine.	**2.1**	Gain ability to research concepts, simulate, and test working conditions and application of modeling.	**a,b,c,d,e,i,k,l**	
3.0	To study the principles involved in assessing the displacement, velocity and acceleration at any point in a link of a mechanism	**3.1**	Identify the path curvature theory and coupler curve of common engineering problems	**a,b,c,d,e,i,k,l**	
4.0	To introduce to students the Concept of synthesis of four bar mechanisms	**4.1**	Select a layout of synthesis of four bar mechanisms	**a,b,c,d,e,i,k,l**	
5.0	To introduce to students the method of synthesis of coupler curve based mechanisms & cam mechanisms using Simulation Software packages	**5.1**	Study and use of mechanism using simulation software packages	**a,b,c,d,e,i,k,l**	

UNIT I : INTRODUCTION	**(12)**
Review of fundamentals of kinematics - classifications of mechanisms-components of mechanisms - mobility analysis - formation of one D.O.F., Compliant mechanisms - Equivalent mechanisms - Basic kinematic structures of serial and parallel robot manipulators.	
UNIT II : KINEMATIC ANALYSIS	**(12)**
Analytical methods for velocity and acceleration Analysis - four bar linkage jerk analysis. Velocity analysis of Plane complex mechanisms using graphical method - Spatial RSSR mechanism - Denavit-Hartenberg Parameters.	
UNIT III : PATH CURVATURE THEORY AND COUPLER CURVE	**(12)**
Fixed and moving centrodes, inflection points and inflection circle. Hartmann's construction - Euler Savary equation, graphical constructions - Bobbilier constructions - Cubic of stationary curvature. Four bar coupler curve - cusp - crunode - coupler driven six - bar mechanisms - straight line generators.	
UNIT IV : SYNTHESIS OF FOUR BAR MECHANISMS	**(12)**
Type synthesis - Number synthesis - Dimensional synthesis - function generation, path generation, motion generation. Associated Linkage Concept. Graphical methods- Inversion technique - point position reduction - two, three and four position synthesis of four-bar mechanisms. Analytical methods - Bloch method and Freudenstein's Equation, Mechanism defects.	
UNIT V : SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS	**(12)**
Cognate Linkgages - parallel motion Linkages. Design of six bar mechanisms-single dwell-double dwell - double stroke. Geared five bar mechanism-multi-dwell. Cam mechanisms- determination of optimum size of cams. Unbalance, Spring surge and Wind up - Study and use of Mechanism using Simulation Software packages. **** Term Project must be submitted at end of the Semester**	
TOTAL : L : 60 = 60 PERIODS	

REFERENCES:

1. Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press. 2012
2. Robert L.Norton, "Design of Machinery", Tata McGraw Hill, 2005
3. Sandor G.N. and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Volume II Prentice Hall, 1984.
4. Amitabh A Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
5. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.

17EDB07 INTEGRATED MECHANICAL DESIGN (Use of Approved Data Book is Permitted)					
		L	T	P	C
		4	0	0	4
PREREQUISITE : 17EDA01					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To know the integrated design procedure of different machine elements for mechanical applications.	**1.1**	Apply concepts of design of shafts to obtain solutions to real time engineering problems	**a,b,c,d,e,i,k,l**	
2.0	To ensure that the student has thorough conceptual understanding of gear and gear boxes	**2.1**	Identify the gear tooth failure modes and design of gears	**a,b,c,d,e,f,i,k,l**	
3.0	To study design concepts of dynamics and thermal aspects of brakes and clutches	**3.1**	Integrated design of brakes and clutches for machine tools	**a,b,c,d,e,f,i,k,l**	
4.0	To study the Design of systems consisting of machine elements	**4.1**	Categorize the engineering applications of Integrated design of machine elements	**a,b,c,d,e,i,k,l**	
5.0	To study the Design of systems consisting of transmission systems	**5.1**	Apply the concepts of integrated design in transmission systems	**a,b,c,d,e,i,k,l**	

UNIT I : FUNDAMENTALS AND DESIGN OF SHAFTS	**(10)**
Phases of design - Standardization and interchange ability of machine elements - Process and Function Tolerances - Individual and group tolerances - Selection of fits for different design situations - Design for assembly and modular constructions - Concepts of integration - BIS, ISO,DIN, BS, ASTM Standards. Oblique stresses - Transformation Matrix - Principal stresses - Maximum shear stress - Theories of Failure - Ductile vs. brittle component design - Analysis and Design of shafts for different applications - integrated design of shaft, bearing and casing - Design for rigidity	
UNIT II : DESIGN OF GEARS AND GEAR BOXES	**(15)**
Principles of gear tooth action - Gear correction - Gear tooth failure modes - Stresses and loads - Component design of spur, helical, bevel and worm gears - Design for sub assembly - Integrated design of speed reducers and multi-speed gear boxes - application of software packages.	
UNIT III : BRAKES & CLUTCHES	**(10)**
Dynamics and thermal aspects of brakes and clutches - Integrated design of brakes and clutches for machine tools, automobiles and mechanical handling equipments.	
UNIT IV: INTEGRATED DESIGN OF MACHINE ELEMENTS	**(12)**
Integrated Design of systems consisting of shaft, bearings, springs - Design of Elevators, Escalators	
UNIT V: INTEGRATED DESIGN OF TRANSMISSION SYSTEMS	**(13)**
Integrated Design of systems consisting of belt, rope, chain, pulleys, gears, gear boxes, valve gear mechanisms	
TOTAL : L : 60 = 60 PERIODS	

REFERENCES:

1. Norton L. R., "Machine Design - An Integrated Approach" Pearson Education, 2005

2. Newcomb, T.P. and Spur, R.T., "Automobile Brakes and Braking Systems", Chapman and Hall, 2nd ed., 1975.
3. Maitra G.M., "Hand Book of Gear Design", Tata McGraw Hill, 1985.
4. Shigley, J.E., "Mechanical Engineering Design", McGraw Hill, 1986.
5. Prasad. L. V., "Machine Design", Tata McGraw Hill, New Delhi, 1992.
6. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.

APPROVED DATA BOOKS :

1. P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol. 1 & 2, Suma Publishers, Bangalore, 1983

17EDP02 ANALYSIS AND SIMULATION LABORATORY					
		L	T	P	C
		0	0	4	2
PREREQUISITE : 17EDP01					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To impart hands-on training with ANSYS software for solving practical problems arising in engineering design.	**1.1**	Analyse the engineering problem using a simulation model and find out the solutions.	**a,b,c,d,e,i,k,l**	
2.0	To simulate the real time problems by using these software and also to understand the application of analysis packages.	**2.1**	Get familiarized with the computer aided finite element analysis packages which are necessary to solve the engineering problems numerically.	**a,b,c,d,e,i,k,l**	
3.0	To develop finite element formulations of engineering problems from a variety of application areas including stress, heat transfer, and vibration analysis.	**3.1**	Design the mechanical systems to meet thermal and fluid flow requirements for various applications	**a,b,c,d,e,i,k,l**	
4.0	Be aware of the limitations of the FEM. Learn to use ANSYS (Commercial finite element programs)	**4.1**	Usage of commercial FE softwares to solve complex engineering problems with an understanding of their limitations.	**a,b,c,d,e,i,k,l**	
5.0	To develop the students to perform Design optimization, Buckling, Modal, Fatigue and Harmonic analysis	**5.1**	Design the mechanical components to meet optimization, Buckling, Modal, Fatigue and Harmonic analysis for various applications	**a,b,c,d,e,i,k,l**	

Analysis of Mechanical Components – Use of FEA Packages. Exercises shall include analysis of

1. Analysis of machine elements under Static loads.
2. Analysis of an Axi-symmetric problem.
3. Modal and Harmonic Analysis.
4. Thermal Analysis of mechanical systems.
5. Non-linear Structural Contact Analysis.
6. Eigen value Buckling Analysis.
7. Fatigue Analysis of a component.
8. Modeling a component using Pro/E, Importing to ANSYS and Meshing.

- Use of kinematics and dynamics simulation software. Analysis of velocity and acceleration for mechanical linkages of different mechanisms.

TOTAL : P: 45 = 45 PERIODS

17EDE01 TECHNICAL SEMINAR					
			L	T	P	C
			0	0	2	1
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To provide exposure to the students to refer, read and review the research articles	**1.1**	Review, prepare and present technological developments	**a,i,j,l**	
2.0	To understand the recent technologies	**2.1**	Get practice of oral and written skills.	**a,i,j,l**	
3.0	To work on a specific technical topic in Engineering design related topics in order to acquire the skills of oral	**3.1**	Improve personal and communicative skills (e.g. speaking, listening, reading, and/or writing).	**a,i,j,l**	
4.0	To acquire technical writing abilities for seminars and conferences.	**4.1**	Adequate to understand inductive and deductive reasoning, and increase their general problem solving skills.	**a,i,j,l**	
5.0	Can interpret and evaluate the quality of the seminar report	**5.1**	Develop the report and also on the interaction during the seminar.	**a,i,j,l**	

SYLLABUS:

The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to engineering design topics and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as audience also should interact. Evaluation will be based on the technical presentation and the report and also on the interaction during the seminar.

TOTAL: P: 45 = 45 PERIODS

17EDE02 PROJECT WORK (PHASE I)					
		L	T	P	C
		0	0	12	6
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature, the methodology to solve the identified problem and preparing project reports and to face reviews and viva-voce examination.	**1.1**	At the end of the course the students will have a clear idea of their area of work and they will be in a position to carry out the phase II project work in a systematic way.	**a,b,c,d,e,f,i,j,k,l**	

SYLLABUS:

The student individually works on a specific topic approved by the head of the department under the guidance of a faculty member who is familiar in this area. The student can select any topic which is relevant to the area of Engineering Design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

17EDE03 INDUSTRIAL TRAINING					
		L	T	P	C
		0	0	4	1
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To get experience about the discipline of working in a professional engineering organization, Interact with other professional and non-professional groups and apply engineering methods such as design and problem solving.	**1.1**	At the end of the course the students will have a clear idea in their area of work and they will be in a position to carry out the phase I and phase II project work in a systematic way.	**a,b,c,d,e,f,i,j,k,l**	

SYLLABUS:

- The students will be required to visit min of two industries and observe the industry functions.
- The students will be required to present min of two technical presentations during this course on current topics related to the specialization. The same will be assessed by a committee appointed by the department.
- The students are expected to submit final report based on the above guidelines.

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TOTAL : P: 45 = 45 PERIODS

17EDE04 PROJECT WORK (PHASE II)					
		L	T	P	C
		0	0	24	12
PREREQUISITE : 17EDE03					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To solve the identified problem based on the formulated methodology.	**1.1**	On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it.	**a,b,c,d,e,f,i,j,k,l**	

SYLLABUS:

The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner

TOTAL : 360 PERIODS

17EDX01 DESIGN OF FLUID POWER SYSTEMS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To impart knowledge on fluid power engineering and power transmission systems	**1.1**	Acquire knowledge about pumps and valves used in fluid power systems	**a,k,l**	
2.0	To create expertise in applications of fluid power systems in automation of machine tools and others equipment	**2.1**	Develop fluid power circuits depends upon the applications.	**a,b,k,l**	
3.0	To design hydraulic and electro-hydraulic systems for automation, pneumatic system circuits and to design low cost automation systems.	**3.1**	Discuss the use the integration of hydraulic and pneumatic systems in other countries and its impact on products design, manufacturing, employment, safety, and economy.	**a,b,d,i,k,l**	
4.0	To learn the various methods of pneumatic systems and circuits design to solve the real world problems.	**4.1**	Recognize the various methods of pneumatic systems and circuits design of the different components used in fluid power and pneumatics systems	**a,b,d,e,i,k,l**	
5.0	To gain knowledge about the PLC, Low cost automation and special circuits	**5.1**	Know the installation and maintenance of the hydraulic and pneumatic circuits	**a,b,c,i,k,l**	

UNIT I : OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS	**(9)**
Fluids - Properties - Types of Fluid power system - Hydraulic Power Generators - Selection and specification of pumps - Pump characteristics. Linear and Rotary Actuators - Selection, Specification and characteristics.	
UNIT II : CONTROL AND REGULATION ELEMENTS	**(6)**
Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems. Electro hydraulic servo valves.	
UNIT III : HYDRAULIC CIRCUITS	**(9)**
Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits – industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits design methodology- design and selection of components - safety and emergency mandrels – Cascade method.	
UNIT IV: PNEUMATIC SYSTEMS AND CIRCUITS	**(9)**
Fundamentals of Pneumatic- Control elements, position and pressure sensing - Logic circuits -Switching circuits - Fringe conditions modules and these integration - Sequential circuits - Cascade methods - Mapping methods - Step counter method - Compound circuit design - Combination circuit design.	
UNIT V: INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS	**(9)**
Pneumatic equipment - Selection of components - Design calculations - Application - Fault finding - Hydro pneumatic circuits - Use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.	
TOTAL : L : 45 = 45 PERIODS	
REFERENCES: 1. Antony Espossito, "Fluid Power with Applications", Pearson education 2008 2. A.Dudley, Pease and J. J. Pippenger, "Basic fluid power", Prentice Hall. 2010	

3. Andrew Parr, “Hydraulic and Pneumatic”, Jaico Publishing House 2004.
4. Bolton. W., “Pneumatic and Hydraulic Systems”, Butterworth - Heinemann, 1997

17EDX02 COMPOSITE MATERIALS AND MECHANICS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the fundamentals of composite material strength and its mechanical behaviour.	**1.1**	Describe the properties of various available composite materials.	**a,e,k,l**	
2.0	Understanding the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.	**2.1**	Understand the mechanics and design related to layered components such as fiber reinforced polymer composites ,isotropic layered structures (example electronic chips) etc and its manufacturing methodologies.	**a,b,c,d,e,k,l**	
3.0	Thermo-mechanical behavior and study of residual stresses in Laminates during processing.	**3.1**	Basic understanding of lamina constitutive equations and lamina properties from laminate tests	**a,b,c,d,e,k,l**	
4.0	Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.	**4.1**	Use the ideas developed in the lamina strength analysis and analysis of laminated flat plates	**a,b,c,d,e,k,l**	
5.0	To introduce thermal analysis of composite materials and mechanics	**5.1**	Select suitable composite or thermal analysis for industrial oriented applications.	**a,b,c,d,e,k,l**	

UNIT I : INTRODUCTION TO COMPOSITE MATERIALS	**(10)**
Definition-Matrix materials - polymers - metals - ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers - fiber fabrication- natural composite wood, Jute - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate - Reinforced composite Materials, Dispersion - Strengthened composite, Fiber-reinforced composites Rule of mixtures - Characteristics of fiber - Reinforced composites, Manufacturing fiber and composites.	
UNIT II : MANUFACTURING OF COMPOSITES	**(10)**
Manufacturing of Polymer Matrix Composites (PMCs) - handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM) - bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquidstate,vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) - hot pressing - reaction bonding process - infiltration technique, direct oxidation- interfaces.	
UNIT III : INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS	**(12)**
Lamina Constitutive Equations: Lamina Assumptions - Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina - Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations - Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.	

UNIT IV : LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES	(8)
Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations - Natural Frequencies.	
UNIT V : THERMAL ANALYSIS	**(5)**
Assumption of Constant Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations - Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.Elaminates, Thermally Quasi-Isotropic Laminates.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994,2nd ed., - CRC press in progress.
2. Mallick, P.K., Fiber -"Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993
3. Hyer, M.W., "Stress Analysis of Fiber - Reinforced Composite Materials", McGraw-Hill, 1998
4. Issac M. Daniel and Orilshai, "Engineering Mechanics of Composite Materials", Oxford University Press - 2006, First Indian Edition - 2007
5. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.
6. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press(India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)
7. Chung, Deborah D.L., "Composite Materials: Science and Applications", Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint, 2009

17EDX03 MECHANICAL BEHAVIOR OF MATERIALS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To know the mechanical behavior of metallic, non-metallic and modern metallic materials under different loading and temperature conditions	**1.1**	Students will demonstrate an understanding of the mechanical properties and behavior of materials.	**a,e,l**	
2.0	To identify various sources of dynamic loads and design approaches of materials	**2.1**	Gain knowledge in selection of materials for the design of engineering structures.	**a,b,e,l**	
3.0	To impart knowledge on relationship between materials selection and processing systems	**3.1**	Know the properties and applications of various materials	**a,b,e,l**	
4.0	To gain knowledge about the modern metallic materials	**4.1**	Demonstrate the ability to identify engineering problems involving plastic deformation, fatigue, and fracture, and the tools required to solve these problems.	**a,b,e,l**	
5.0	To gain knowledge about the non metallic materials	**5.1**	Familiarize in the area of material behaviour under different loading and temperature conditions.	**a,e,l**	

UNIT I : BASIC CONCEPTS OF MATERIAL BEHAVIOR	**(9)**
Elasticity in metals and polymers - Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour -Super plasticity -Theories of failure - Griffith's theory - Ductile, brittle transition in steel - creep.	
UNIT II : BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES	**(6)**
Stress intensity factor and fracture toughness - Fatigue, fatigue test, fatigue crack propagation under constant load and variable load mechanisms and Paris law - fail - safe design approaches - Effect of surface and metallurgical parameters on fatigue - Failure analysis, sources of failure, procedure of failure analysis-Impact effects - Notch effects	
UNIT III : SELECTION OF MATERIALS	**(9)**
Motivation for selection, cost basis and service requirements - Selection for mechanical properties - Selection for surface durability corrosion and wear resistance - Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery, nuclear and high temperature applications - Computer aided materials selection.	
UNIT IV: MODERN METALLIC MATERIALS	**(12)**
Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel - Intermetallics, Ni and Ti aluminides, Super plasticity materials - smart materials, shape memory alloys - Metallic glass and nano crystalline materials. Nano structured coatings, thin films, CNT.	
UNIT V: NON METALLIC MATERIALS	**(9)**

Polymeric materials - Formation of polymer structure - Production techniques of fibers, foams, adhesives and coating - structure, properties and applications of engineering polymers - Advanced structural ceramics, bio degradable ceramics. WC, TiC, TaC, Al_2O_3, SiC, Si_3N_4 CBN and diamond - properties, processing and applications.

TOTAL : L : 45 PERIODS

REFERENCES:

1. Thomas H. Courtney, Mechanical Behavior of Materials, (2nd ed), McGraw Hill, 2000
2. Flinn, R.A., and Trojan, P.K., "Engineering Materials and their Applications", 4th ed. Jaico, 1999.
3. George E.Dieter, "Mechanical Metallurgy", McGraw Hill, 1988
4. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., "Selection and use of Engineering Materials", 3rd ed., Butterworth-Heiremann, 1997.
5. Metals Hand book, Vol.10, "Failure Analysis and Prevention", 10th ed., Jaico, 1999.
6. Ashby M.F., "Materials selection in Mechanical Design", 2nd ed., Butter worth, 1999.

17EDX04 MAINTENANCE ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To enable the student to understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.	**1.1**	Be familiar with the basics of maintenance systems.	**a,e,i,k,l**	
2.0	To explain the different maintenance strategies like Preventive maintenance, condition monitoring and repair of machine elements.	**2.1**	Gain ability to plan and schedule maintenance activities.	**a,b,d,e,i,k,l**	
3.0	To illustrate some of the simple instruments used for condition monitoring	**3.1**	Be familiar with the safety and other aspects of maintenance functions.	**a,b,d,e,i,k,l**	
4.0	to learn the planning and scheduling of activities in spare Parts management techniques	**4.1**	Establish maintenance strategies according to system characteristics and design transition programs to implement these strategies	**a,b,d,e,i,k,l**	
5.0	To introduce the safety and other aspects of maintenance functions	**5.1**	Describe different types of accidents and hazards.	**a,c,e,f,i,k,l**	

UNIT I : INTRODUCTION TO MAINTENANCE SYSTEMS	**(9)**
Introduction to repair and Maintenance - Maintenance as business - Maintenance systems such as reactive, preventive, predictive or proactive systems - Human resources management in Maintenance management -maintainability - Inherent and overall availability - Mean time between failures, mean time to repairs and mean down time - Testability and supportability - Design for Maintenance - Poor maintainability aspects - Design for reliability.	
UNIT II : CONDITION BASED MAINTENANCE	**(9)**
Condition based monitoring of equipment and systems - condition monitoring techniques such as a) Vibration analysis, b) Ultrasonic detection techniques, c) Thermography, d) Oil and lubricant analysis, e) Motor condition monitoring (MCM) - Shaft alignments through laser - Vibration instruments - Outline on Thermography.	
UNIT III : MAINTENANCE TECHNIQUES SUCH AS RCM, TPM & CMMS	**(9)**
Reliability centred Maintenance - Failure Mode and Effect Analysis - Root cause Analysis - logic tree analysis -Criticality matrix - Total Productive Maintenance, Overall Equipment Effectiveness - Lean manufacturing - TPM and TPO - Relationship between OEE and world - class Maintenance - Ladder of Maintenance improvement- Computerized Maintenance management system in a business scenario - data acquisition for effective management of CMMS.	
UNIT IV : ASSET PLANNING AND SCHEDULING OF ACTIVITIES IN MAINTENANCE	**(9)**
Asset and spare part management, - Conventional spare Parts management techniques such as Economic Order Quantity, two bin systems - Latest trends in monitoring through bar codes, mobile computer and wireless data transmissions - Different aspects of planning and scheduling of Maintenance, such as shutdowns - Critical aspects of both routine and shut down Maintenance - Bar charts - PERT network during shut down - Man power Training and utilization of skilled manpower - Sequencing of activities.	
UNIT V : SAFETY AND OTHER ASPECTS OF MAINTENANCE FUNCTIONS	**(9)**

Safety Engineering - Hazard analysis - General rules and guidelines in safety and hazard prevention - Analytical tools - Hazard analysis - Fault Tree Analysis - Sneak Circuit analysis - Integrated approach to Maintenance - Statistical distributions such as normal, gamma and Weibull in Maintenance - Maintenance effectiveness.

TOTAL : L: 45 = 45 PERIODS

REFERENCES:

1. Venkataraman.K, “Maintenance Engineering and Management”, PHI Learning-2007.
2. Kelly. A and Harris, M. J, “Management of Industrial Maintenance”, Butter worth & Co., 1978.
3. David J. Smith, “Reliability and Maintainability in Perspective”, McMillan, 2nd ed., 1985.
4. Gwidon W Stachowiak and Andrew W. Batchelor, “Engineering Tribology”, Butterwork-Heinmann, 2001.
5. John V.Grimaldi & Rollin H.Simonds, “Safety Management”, AITBS Publishers & Distributors, 2001

17EDX05 DESIGN OF MATERIAL HANDLING EQUIPMENT (Use of approved Data Book is permitted)					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To impart basic concept of material handling	**1.1**	Design the various equipments for material handling in industries.	**a,f,k,l**	
2.0	To give comprehensive insight in to design of hoists	**2.1**	Determine the requirement of different material handling equipments for various applications.	**a,b,c,e,f,k,l**	
3.0	To gain knowledge about the drives of hoisting gear	**3.1**	Identify engineering problems and to carry out the engineering design of a design or component to meet desired needs	**a,b,c,e,f,k,l**	
4.0	To outline the conveyors as a creative art design.	**4.1**	Research concept, simulate, test working conditions and applications of modeling methods and their impact on the desired system	**a,b,c,e,f,k,l**	
5.0	To introduce the rudiments of elevators design principles.	**5.1**	To design the elevators with loading and bucket arrangements in consideration of safety.	**a,b,c,e,f,k,l**	

UNIT I: MATERIALS HANDLING EQUIPMENT	**(9)**
Intraplant transporting facilities - Types - Principle groups of material handling equipment - Choice of material handling equipment - Types of material handling equipment - General characteristics - Applications.	
UNIT II : DESIGN OF HOISTS	**(9)**
Welded and roller chains - Hemp and wire ropes Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks - crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.	
UNIT III : DRIVES OF HOISTING GEAR	**(9)**
Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - Trackless travelling mechanism - Slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.	
UNIT IV : CONVEYORS	**(9)**
Types - description - design and applications of belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.	
UNIT V : ELEVATORS	**(9)**
Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices, stackers - Design of fork lift trucks.	
TOTAL : L : 45 = 45 PERIODS	
REFERENCES: 1. Alexandrov, M., "Materials Handling Equipments", MIR Publishers, 2002. 2. R. B.Chowdary and G. R. N.Tagore, "Material Handling Equipments", Khannna Publishers, 2003.	

3. Rudenko, N., “Materials Handling Equipment”, ELnvee Publishers, 1970.
4. Spivakovsy, A.O. and Dyachkov, V.K., “Conveying Machines, Volumes I and II”, MIR Publishers, 1985.
5. Boltzharol, A., “Materials Handling Handbook”, The Ronald Press Company, 2009.
6. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2012.

17EDX06 EXPERIMENTAL STRESS ANALYSIS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the basic aspects of experimental stress analysis	**1.1**	Recognize the area of application for this methods for the health monitoring systems the structures	**a,b,c,d,e,i,k,l**	
2.0	To understand the emerging techniques like digital image correlation	**2.1**	Evaluate the stress at the critical points and to measure the severity of damage that occur due to the expose of the structures to the adverse loading condition	**a,b,c,d,e,i,k,l**	
3.0	To understand the fundamental aspects of three dimensional photo elasticity and digital photo elasticity.	**3.1**	Measure the severity of damage under complex loadings for the load bearing structures	**a,b,c,d,e,i,k,l**	
4.0	To introduce the photo elastic coatings analysis of brittle coatings	**4.1**	Understand basic principles of photo elasticity, and use it as an analysis tool	**a,b,c,d,e,i,k,l**	
5.0	To gain knowledge about the non destructive testing methods	**5.1**	Aviation of control to develop trend and technique ability by applying the Non destructive testing methods.	**a,b,c,d,e,i,k,l**	

UNIT I: EXPERIMENTAL STRESS ANALYSIS USING STRAIN GUAGUES	**(9)**
Overview of Experimental Stress Analysis - Optical Methods Work as Optical Computers - Stress - Strain and Displacement Fields. Introduction to Strain Gauges - Strain Sensitivity of a Strain Gauge - Bridge Sensitivity - Rosettes, Strain Gauge Alloys, Carriers and Adhesives. Performance of Strain Gauge System - Temperature Compensation - Two-wire and Three - wire Circuits. Correction Factors for Special Applications - Special Gauges	
UNIT II : TRANSMISSION PHOTOELASTICITY	**(9)**
Physical Principle of Strain Gauges - Photo elasticity and Moiré - Hologram Interferometry - Speckle Methods - Introduction to Shearography - TSA, DIC and Caustics. Fringe Patterns - Richness of Qualitative Information - Multi-Scale Analysis in Experimental Mechanics, Selection of an Experimental Technique.	
UNIT III : THREE DIMENSIONAL PHOTOELASTICITY AND DIGITAL PHOTOELASTICITY	**(9)**
Introduction to Transmission Photo elasticity - Ordinary and Extraordinary Rays - Light Ellipse, Passage of Light Through a Crystal Plate, Retardation Plates, Stress - optic Law, Determination of Photo elastic Parameters at an Arbitrary Point, Tardy's Method of Compensation, Calibration of Photo elastic Materials, Fringe Thinning Methodologies, Fringe Ordering in Photo elasticity, Miscellaneous Topics in Transmission Photo elasticity, Three Dimensional Photo elasticity, Overview of Digital Photo elasticity.	
UNIT IV : PHOTOELASTIC COATINGS AND BRITTLE COATINGS	**(9)**
Introduction to Photo elastic Coatings - Correction Factors for Photoelastic Coatings, Coating Materials - Selection of Coating Thickness, Industrial Application of Photoelastic Coatings, Calibration of Photo elastic Coatings. Introduction to Brittle Coatings - Analysis of Brittle Coatings.	
UNIT V: NON DESTRUCTIVE TESTING METHODS	**(9)**
Load testing on structures, buildings, bridges and towers - Rebound Hammer - Acoustic emission - Sound level meter - Ultrasonic testing principles and application - Holography - use of laser for structural testing - Vibration transducers for velocity and acceleration measurements - Vibrometer - Vibration Analyser	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Sadhu Singh - “Experimental Stress Analysis”, Khanna Publishers, New Delhi, 2009.
2. JW Dalley and WF Riley, “Experimental Stress Analysis”, McGraw Hill Book Company, N.Y. 1991
3. L.S.Srinath et al., “Experimental Stress Analysis”, Tata McGraw Hill Company, New Delhi, 1984
4. R.S.Sirohi, HC Radhakrishna, “Mechanical Measurements”, New Age International (P) Ltd. 2013

17EDX07 ADVANCED TOOL DESIGN					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17EDB02					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the design process and products.	**1.1**	Apply the design concepts in various industrial applications	**a,b,c,d,e,k,l**	
2.0	To understand the selection of proper materials and design for manufacture.	**2.1**	Gain knowledge about standards in tool design	**a,b,c,d,e,f,k,l**	
3.0	To understand various types of tools and their application.	**3.1**	Design the tools for NC machines	**a,b,c,d,e,f,k,l**	
4.0	To gain proficiency in the development of required views of the final design	**4.1**	Design fixtures for milling, boring, lathe, grinding, welding; identify fixtures and cutting tools for NC machine tools.	**a,b,c,d,e,f,k,l**	
5.0	To gain knowledge about the tool design for numerically controlled machine tools	**5.1**	Describe tool design methods and punch and die manufacturing techniques.	**a,b,c,d,e,k,l**	

UNIT I : INTRODUCTION TO TOOL DESIGN	**(9)**
Introduction - Tool Engineering - Tool Classifications - Standards in tool design -Tool Design Objectives - Tool Design in manufacturing - Challenges and requirements - Planning the tool design - Limits and fits - Tooling Materials - Ferrous and Non ferrous Tooling Materials - Carbides, Ceramics and Diamond - Nonmetallic tool materials.	
UNIT II : DESIGN OF DRILL JIGS	**(10)**
Introduction - Fixed Gages - Gage Tolerances - Selection of material for Gages - Indicating Gages - Automatic gages - Principles of location - Locating methods and devices - Principles of clamping - Drill jigs - Chip formation in drilling - General considerations in the design of drill jigs - Drill bushings - Methods of construction - Drill jigs and modern manufacturing.	
UNIT III : DESIGN OF FIXTURES	**(8)**
Introduction - Fixtures and economics - Types of Fixtures - Vise Fixtures - Milling Fixtures - Boring Fixtures - Broaching Fixtures - Lathe Fixtures - Grinding Fixtures.	
UNIT IV :DESIGN OF PRESS TOOL DIES	**(9)**
Types of Die construction - Die-design fundamentals - Blanking and Piercing die construction - Pilots - Strippers and pressure pads - Presswork materials - Strip layout - Short-run tooling for Piercing - Bending dies - Forming dies - Drawing operations.	
UNIT V :TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE TOOLS	**(9)**
Introduction - Need for numerical control - Basic explanation of numeric control - Numerical control systems in use today (Tool for numerical control machine) - Fixture design for numerically controlled machine tools - Cutting tools for numerical control - Tool holding methods for numerical control - Automatic tool changers and tool positioners - Tool presetting - Introduction - General explanation of the Brown and sharp machine - Tooling for Automatic screw machines.	
TOTAL : L: 45 = 45 PERIODS	
REFERENCES:	
1. B. L.Juneja and G S.Sekhon, "Fundamentals of Metal cutting and Machine tools", New Age International (P) Ltd., New	

Delhi, 2005.
2. C. Donaldson, G. H.Lecain and V. C.Goold , “Tool Design” , Tata McGraw- Hill, 2007
3. Edward G.Hoffman , “Jig and Fixture Design”, Thomsonasia Pvt Ltd, Singapore, 2004.
4. R.A.Lindberg, “Process and Materials of Manufacture”, Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.

17EDX08 BIOMECHANICS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To gain the knowledge on exposed to principles of mechanics.	**1.1**	Describe the mechanics of physiological systems.	**a,e,l**	
2.0	To Learn the mechanics of physiological systems.	**2.1**	Analyze the biomechanical systems.	**a,b,c,e,l**	
3.0	To familiar with the mathematical models used in the analysis of biomechanical systems	**3.1**	Gain knowledge about bone structure & composition mechanical properties	**a,b,c,e,l**	
4.0	To understand the characteristics of different types of biomaterials and manufacturing process of implants system.	**4.1**	Design orthopaedic applications.	**a,b,c,e,l**	
5.0	To familiarize the students about the various modeling and ergonomics system	**5.1**	Explain the ergonomics and Injury mechanics	**a,b,c,e,l**	

UNIT I : INTRODUCTION TO MECHANICS	**(9)**
Principles of Mechanics, Vector mechanics, Mechanics of motion - Newton's laws of motion, Kinetics, Kinematics of motion, Fluid mechanics - Euler equations and Navier Stoke's equations, Visco elasticity, Constitutive equations, Stress transformations, Strain energy function.	
UNIT II : BIOFLUID MECHANICS	**(9)**
Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and Hagen-poiseuille equation, turbulent flow. Cardiovascular system - biological and mechanical valves development, artificial heart valves testing of valves, Structure, functions, material properties and modeling of Blood vessels.	
UNIT III : BIOSOLID MECHANICS	**(9)**
Hard Tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models - anisotropy. Soft Tissues: Structure, functions, material properties and modeling of Soft Tissues: Cartilage, Tendon, Ligament, Muscle.	
UNIT IV : BIOMECHANICS OF JOINTS AND IMPLANTS	**(9)**
Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle. Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants..	
UNIT V : MODELING AND ERGONOMICS	**(9)**
Introduction to Finite Element Analysis, Analysis of bio mechanical systems using Finite element methods, Graphical design. Ergonomics- Gait analysis, Design of work station, Sports biomechanics, Injury mechanics.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Duane Knudson, "Fundamentals of Biomechanics", 2nd Edition Springer Science Business Media, 2007
2. Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design",

Springer Science Business Media, 2004.
3. Marcelo Epstein, “The Elements of Continuum Biomechanics”, ISBN: 978-1-119-99923-2, 2012.
4. Shrawan Kumar, “Biomechanics in Ergonomics”, Second Edition, CRC Press 2007.
5. Y.C. Fung, “Bio-Mechanics- Mechanical Properties of Tissues”, Springer-Verlag, 1998.

17EDX09 MECHATRONICS IN MANUFACTURING SYSTEMS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To develop interdisciplinary knowledge on electronics, electrical, mechanical and computer systems for the design of mechanical and electronic systems.	**1.1**	Describe the various types of sensors and transducers.	**a,l**	
2.0	To impart the knowledge on microprocessors and their interfacing with mechanical systems.	**2.1**	Program the microprocessor.	**a,b,e,l**	
3.0	To familiarize with the microprocessors in mechatronics.	**3.1**	Select suitable components for industrial automation.	**a,b,c,e,l**	
4.0	The course also introduces its connections with design of fluid power circuits	**4.1**	Gain the knowledge to design the fluid power circuits and analysis of hydraulic circuits.	**a,b,c,e,k,l**	
5.0	To gain knowledge about the real time interfacing systems.	**5.1**	Understand the basic knowledge of sensors, actuators and various instruments involved in mechatronics system.	**a,b,c,e,f,k,l**	

UNIT I : INTRODUCTION	**(9)**
Introduction to Mechatronics - Systems - Mechatronics in Products - Mechatronics approach for design process, modeling of engineering systems, modeling system with spring, damper and mass, modeling chamber filled with fluid, modeling pneumatic actuator. Transfer functions, frequency response of systems.	
UNIT II : SENSORS AND TRANSDUCERS	**(9)**
Sensors for motion and position measurement, force, torque, tactile, temperature sensors, ultrasonic sensors, magnetostrictive sensors.	
UNIT III : MICROPROCESSORS IN MECHATRONICS	**(9)**
Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters - Applications - Temperature control - Stepper motor control - Traffic light controller.	
UNIT IV : AUTOMATION SYSTEM DESIGN	**(9)**
Design of fluid power circuits - cascade, KV-map and step counter method. PLC - Basic structure - Input / Output processing - Programming of PLC. Sizing of components in pneumatic and hydraulic systems. Analysis of hydraulic circuits.	
UNIT V : REAL TIME INTERFACING	**(9)**
Introduction to data acquisition and control systems, overview of I/O process, virtual Instrumentation, interfacing of various sensors and actuators with PC, Condition monitoring, SCADA systems. Traditional Mechatronics design - Designing - Possible design solutions – Case studies of Mechatronics systems.	
TOTAL : L : 45 = 45 PERIODS	
REFERENCES:	
1. Bradley. D.A, Dawson.D., Buru.N.C. and Loader.A.J., “Mechatronics”, Chapman and Hall,2008.	

2. Devdas shetty and Richard A.Kolk., “Mechatronics System Design”, PWS Publishing company, USA, 2010.
3. Sanjay Gupta and Joseoh John, “Virtual Instrumentation using Lab VIEW”, Tata McGraw Hill Publications, 2005.
4. Sabrie soloman, “Sensors and Control System in Manufacturing”, McGraw Hill, Inc, 2010.
5. HMT, “Mechatronics”, Tata McGraw Hill Publications, 2005.

17EDX10 BEARING DESIGN AND ROTOR DYNAMICS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To know about different types of bearings available for machine design and their operating principles	**1.1**	Explain different types of bearings available for machine design and their operating principles	**a,b,f,k,l**	
2.0	To design hydrodynamic/ hydrostatic / rolling bearing for given specifications and analyze the bearings for their performance	**2.1**	Acquisition of knowledge in the analysis of all types of bearings.	**a,b,c,d,e,f,k,l**	
3.0	To gain knowledge about the selection and design of rolling bearings	**3.1**	Ability to make specifications of all types of bearings	**a,b,c,d,e,f,k,l**	
4.0	To introduce dynamics of hydrodynamic bearing design.	**4.1**	Skill for conducting dynamic / vibration analysis and troubleshooting of bearings	**a,b,c,d,e,f,k,l**	
5.0	To know about rotor vibration and design configurations of stable journal bearings	**5.1**	Analysis the vibrating devices and critical speed of shafts.	**a,b,c,d,e,f,k,l**	

UNIT I : CLASSIFICATION AND SELECTION OF BEARINGS	**(6)**
Selection criteria - Dry and Boundary Lubrication Bearings - Hydrodynamic and Hydrostatic bearings - Electro Magnetic bearings - Dry bearings - Rolling Element bearings - Bearings for Precision. Applications - Foil Bearings - Special bearings - Selection of plain Bearing materials - Metallic and Non metallic bearings.	
UNIT II : DESIGN OF FLUID FILM BEARINGS	**(10)**
Design and performance analysis of Thrust and Journal bearings - Full, partial, fixed and pivoted journal bearings design procedure - Minimum film thickness - lubricant flow and delivery - power loss, Heat and temperature distribution calculations - Design based on Charts & Tables and Experimental curves - Design of Foil bearings - Air Bearings - Design of Hydrostatic bearings -Thrustand Journal bearings - Stiffness consideration - flow regulators and pump design	
UNIT III : SELECTION AND DESIGN OF ROLLING BEARINGS	**(10)**
Contact Stresses in Rolling bearings - Centrifugal stresses - Elasto hydrodynamic lubrication - Fatigue life calculations- Bearing operating temperature - Lubrication- Selection of lubricants - Internal clearance - Shaft and housing fit- - Mounting arrangements - Materials for rolling bearings-Manufacturing methods - Ceramic bearings - Rolling bearing cages - bearing seals selection	
UNIT IV : DYNAMICS OF HYDRODYNAMIC BEARINGS	**(10)**
Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearing sand thrust bearings - Rotating loads , alternating and impulse loads in journal bearings - Journal centre Trajectory - Analysis of short bearings under dynamic conditions - Finite difference solution for dynamic conditions	
UNIT V : ROTOR DYNAMICS	**(9)**
Rotor vibration and Rotor critical speeds - Support stiffness on critical speeds - Stiffness and damping coefficients of journal bearings - Computation and measurements of journal bearing coefficients - Mechanics of Hydro dynamic Instability - Half frequency whirl and Resonance whip - Design configurations of stable journal bearings	
TOTAL : L : 45 = 45 PERIODS	
REFERENCES:	

1. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
2. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice -Hall of India PvtLtd , New Delhi, 2005
3. Neale, M.J. “Tribology Hand Book”, Butterworth Heinemann, United Kingdom 2001.
4. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
5. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
6. G.W.Stachowiak & A.W .Batchelor , Engineering Tribology, Butterworth-Heinemann, UK, 2005

17EDX11 ADDITIVE MANUFACTURING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand a class of rapid prototyping (RP) technologies for rapid product development	**1.1**	Apply the tools and techniques for rapid production of products with complicated shapes at low cost.	**a,e,l**	
2.0	To introduce reverse engineering and CAD modeling	**2.1**	Determine the suitable rapid prototyping technology and their potential to support design and manufacturing.	**a,b,c,e,k,l**	
3.0	To familiarize the students about the various rapid prototyping process	**3.1**	Be familiar with challenges associated with reverse engineering and data processing tools and the case studies relevant to rapid manufacturing and tooling.	**a,b,c,e,k,l**	
4.0	To gain knowledge about the applications of rapid prototyping	**4.1**	Select the appropriate fabrication technology while considering the reverse engineering and CAD modelling.	**a,b,c,e,k,l**	
5.0	To acquaint the student with rapid tooling techniques used in wide variety of situations.	**5.1**	Gain the knowledge in Direct tooling and indirect tooling for various manufacturing process.	**a,b,c,e,k,l**	

UNIT I : INTRODUCTION	**(8)**
Need - Development of RP systems - RP process chain - Impact of Rapid Prototyping and Tooling on Product Development - Benefits - Need for Prototyping - Issues in Prototyping - Conducting Prototyping - Design Procedure - Prototype Planning and Management - Product and Prototype Cost Estimation - Fundamentals of Cost Concepts - Prototype Cost Estimation - Cost Complexities.	
UNIT II : REVERSE ENGINEERING AND CAD MODELING	**(9)**
Basic concept- Digitization techniques - Model Reconstruction - Data Processing for Rapid Prototyping : CAD model preparation, Data Requirements - geometric modeling techniques : Wire frame, surface and solid modeling - data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.	
UNIT III : TYPES OF RP PROCESS	**(10)**
Direct Metal Laser Sintering, Direct shell production casting, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations - Case Studies	
UNIT IV : APPLICATIONS OF RAPID PROTOTYPING	**(10)**
Investment Casting - Sand Casting - Permanent Mould Casting - Direct RP Tooling - Silicone Rubber Tooling - Investment Cast Tooling - Powder Metallurgy Tooling - Desktop Machining - Case Studies on Current Applications of RP- Novel Application of RP Systems - Future Trends of RP Systems.	
UNIT V : RAPID TOOLING	**(7)**
Classification: Soft tooling - Direct, Indirect - Hard tooling - Direct, Indirect - Case studies - automotive, aerospace and Biomedical industries.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Ali K. Kamrani, Emad Abouel Nasr, "Rapid Prototyping: Theory and practice", Springer, 2006.
2. LiouW.Liou, Frank W.Liou, "Rapid Prototyping and Engineering applications: A tool box for prototype

Development", CRC Press, 2007.
3. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", 3rd ed, World Scientific Publishers, 2010.
4. Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
5. Cooper, G.K , Rapid Prototyping Technology Selection and Application, Marcel Dekker Inc, USA, 2001
6. Hopkinson, N., Hague, R.J.M, and Dickens, P.M. ,Rapid Manufacturing, An Industrial Revolution for the Digital Age, John Wiley & Sons, Ltd, UK ,2006
7. Liou, W.F, Rapid Prototyping and Engineering Applications, A toolbox for prototype development, CRC Press, Taylor & Francis Group LLC, USA ,2008
8. Kai., C.C, Lim, C.S. and Leong, F.K. ,Rapid Prototyping: Principles and Applications in Manufacturing, Wiley Publication ,2008.

17EDX12 ADVANCED METALFORMING TECHNIQUES					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To study the concepts of latest metal forming techniques and their applications in metal forming industry.	**1.1**	learn the basics of plasticity and forming	**a,e,l**	
2.0	To study the thermo mechanical regimes and its requirements of metal forming	**2.1**	Attain proficiency in basic metal forming techniques, forging, extrusion, drawing and rolling.	**a,b,e,l**	
3.0	To gain knowledge about the sheet metal forming process	**3.1**	Develop the product using sheet metal forming with conventional process.	**a,b,c,e,l**	
4.0	To gain knowledge about the powder metallurgy and special forming processes	**4.1**	Fabricate basic parts and assemblies using powered and non-powered machine shop equipment in conjunction with mechanical documentation.	**a,b,c,e,l**	
5.0	To develop a thorough understanding of the electromagnetic forming and its applications	**5.1**	Describe the latest metal forming techniques and help them decide on the suitable method to form the metals for various industrial applications.	**a,b,e,l**	

UNIT I: INTRODUCTION TO THEORY OF PLASTICITY AND FORMING	**(9)**
Theory of plastic deformation - Yield criteria - Tresca and Von-mises - Distortion energy - Stress strain relation - Mohr's circle representation of a state of stress - cylindrical and spherical coordinate system - upper and lower bound solution methods - thermo elastic Elasto plasticity - Elasto Visco plasticity.	
UNIT II : THEORY AND PRACTICE OF BULK FORMING PROCESSES	**(9)**
Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing - Effect of friction - calculation of forces, work done - Process parameters, equipment used - Defects - applications - Recent advances in Forging, Rolling, Extrusion and Drawing processes - Design consideration in forming - Formability of laminated sheet - Overview of FEM applications in metal forming analysis.	
UNIT III : SHEET METAL FORMING	**(9)**
Formability studies - Conventional processes - H E R F techniques - Super plastic forming techniques - Hydro forming - Stretch forming - Water hammer forming - Principles and process parameters - Advantage, Limitations and application.	
UNIT IV : POWDER METALLURGY AND SPECIAL FORMING PROCESSES	**(9)**
Overview of P/M technique - Advantages - applications - Powder perform forging - powder rolling - Tooling, process parameters and applications - Orbital forging - Isothermal forging - Hot and cold isostatic pressing - High speed extrusion - Rubber pad forming - Fine blanking - LASER beam forming.	
UNIT V : ELECTROMAGNETIC FORMING AND ITS APPLICATIONS	**(9)**
Electromagnetic forming process - Electro - magnetic forming machines - Process variables - Coils and Dies - Effect of resistivity and geometry - EM tube and sheet forming, stamping, shearing and welding - Applications - Finite element analysis of EM forming.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 2004
2. Altan.T, Soo-Ik-Oh, Gegel, HL – Metal forming, fundamentals and Applications, American Society of Metals,

Metals Park, Ohio, 1983
3. Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003.
4. ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
5. Shiro Kobayashi, Soo-Ik-Oh-Altan, T,Metal forming and Finite Element Method, Oxford University Press, 2001.
6. Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elesevier, 2006
7. SAE Transactions, Journal of Materials and Manufacturing Section 5, 1993-2007

17EDX13 OPTIMIZATION TECHNIQUES IN DESIGN					
			L	T	P	C
			3	0	0	3
PREREQUISITE : 17EDA01					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To get knowledge on one minimization methods namely elimination methods, interpolation methods and direct root methods	**1.1**	Solve one dimensional minimization problems using elimination or interpolation methods	**a,b,c,d,e,k,l**	
2.0	To understand various unconstrained and constrained minimization methods	**2.1**	Determine optimal solution for constrained/unconstrained optimization problems using appropriate method	**a,b,c,d,e,k,l**	
3.0	To provide an exposure about the design applications of geometric and stochastic programming.	**3.1**	Describe the methods of optimization techniques(indirect and direct methods)	**a,b,c,d,e,k,l**	
4.0	To know various modern optimization techniques	**4.1**	Describe the steps involved in geometric, Stochastic programming and modern methods of optimization.	**a,b,c,d,e,k,l**	
5.0	To gain knowledge about the modern methods of optimization techniques.	**5.1**	Demonstrate the knowledge of modern methods of optimization.	**a,b,c,d,e,k,l**	

UNIT I : ONE DIMENSIONAL MINIMIZATION METHODS	**(9)**
Unimodal function - Elimination methods -unrestricted search - exhaustive search - dichotomous search - interval halving method - ibonacci method - golden section method - interpolation methods-quadratic and cubic interpolation methods - direct root methods - Newton method - Quasi Newton method - secant method	
UNIT II : UNCONSTRAINED OPTIMIZATION TECHNIQUES	**(9)**
Classification of unconstrained minimization methods - direct search methods - random walk method - univariate method - Powell's method - simplex method - Indirect search methods - steepest descent method - Fletcher - Reeves method - Newton's method - Marquardt method - Broyden-Fletcher-Goldfarb-Shanno (BFGS) Method	
UNIT III : CONSTRAINED OPTIMIZATION TECHNIQUES	**(9)**
Direct Methods - Sequential Linear Programming(SLP) - Zoutendijk's method of feasible directions - Rosen's gradient projection method - Generalized Reduced Gradient (GRG) method - sequential quadratic programming - Indirect Methods - interior penalty function method - exterior penalty function method - Augmented Lagrange Multiplier (ALM) method	
UNIT IV : GEOMETRIC AND STOCHASTIC PROGRAMMING	**(9)**
Unconstrained geometric programming problem - differential calculus method - arithmetic-geometric inequality method - constrained geometric programming problem - mixed inequality constraints - applications - formulation of geometric programming problems of design of hydraulic cylinder and helical spring - Stochastic nonlinear programming and geometric programming in design	
UNIT V : MODERN METHODS OF OPTIMIZATION	**(9)**
Genetic algorithms - Simulated annealing - Particle swarm optimization - Ant colony optimization - Optimization of fuzzy systems – Neural - Network - Based Optimization.	
TOTAL : L : 45 = 45 PERIODS	
REFERENCES:	
1. Rao.S.S, "Engineering Optimization – Theory and Practice", 4th ed., John Wiley & Sons, 2009	
2. Ashok D. Belegundu, Tirupathi R. Chandrupatla, "Optimization Concepts and Applications in Engineering",	

2nd ed., Cambridge University Press, 2011
3. Kalyanamoy Deb, “Optimization for Engineering Algorithms and Examples”, Prentice Hall of India, 2005.
4. Charles L. Byrne, “A First Course in Optimization”, CRC Press, 2015
5. Edwin K.P Chong, Stanislaw H. Zak, “An Introduction to Optimization”, 2nd ed., John Wiley & Sons, 2001

17EDX14 COMPUTATIONAL FLUID DYNAMICS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17EDA01,17EDB05					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To introduce ggoverning eequations of viscous fluid flows.	**1.1**	Classify the basic equations of fluid dynamics	**a,b,c,d,e,i,k,l**	
2.0	To introduce numerical modeling and its role in the field of fluid flow and heat transfer.	**2.1**	Solve complex problems in the field of heat transfer.	**a,b,c,d,e,i,k,l**	
3.0	To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.	**3.1**	Solve complex problems in the field of CFD	**a,b,c,d,e,i,k,l**	
4.0	To apply the concepts to the finite volume method for convection diffusion	**4.1**	Analysis of accuracy and stability of finite difference methods for model equations.	**a,b,c,d,e,i,k,l**	
5.0	To give detailed study of calculation flow field by FVM	**5.1**	Examine and assessing basic numerical methods for fluid flow problems.	**a,b,c,d,e,i,k,l**	

UNIT I : GOVERNING EQUATIONS AND BOUNDARY CONDITIONS	**(3)**
Basics of computational fluid dynamics - Governing equations of fluid dynamics - Continuity, Momentum and Energy equations - Physical boundary conditions - Time-averaged equations for Turbulent Flow - Turbulent - Kinetic Energy Equations - Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.	
UNIT II : FINITE DIFFERENCE METHOD	**(12)**
Derivation of finite difference equations - Simple Methods - General Methods for first and second order accuracy - solution methods for finite difference equations - Elliptic equations - Iterative solution Methods - Parabolic equations - Explicit and Implicit schemes - Example problems on elliptic and parabolic equations	
UNIT III : FINITE VOLUME METHOD (FVM) FOR DIFFUSION	**(12)**
Finite volume formulation for steady state One, two and three - dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank - Nicolson and fully implicit schemes.	
UNIT IV : FINITE VOLUME METHOD FOR CONVECTION DIFFUSION	**(9)**
Steady one-dimensional convection and diffusion - Central, upwind differencing schemes-properties of discretization schemes - Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, Quick Schemes.	
UNIT V : CALCULATION FLOW FIELD BY FVM	**(9)**
Representation of the pressure gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and Velocity corrections - Pressure Correction equation, Simple algorithm and its variants. Turbulence models, mixing length model, two equation (k-Є) models - High and low Reynolds number models.	
TOTAL : L: 45 = 45 PERIODS	

REFERENCES:

1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Longman, 1998.
2. T.J. Chung, "Computational Fluid Dynamics", Cambridge University Press, 2002.
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.
4. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.

17EDX15 DESIGN OF PRESSURE VESSEL AND PIPING					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To educate the means of flow distribution and stress analysis in pressure vessels.	**1.1**	Predict the thermal behavior and carry out a stress analysis in pressure vessels.	**a,b,c,d,e,i,k,l**	
2.0	To understand the stress analysis of piping layout	**2.1**	Design the pressure vessels and piping layout for industrial applications.	**a,b,c,d,e,i,k,l**	
3.0	To get a basic understanding of the design of vessels	**3.1**	Analyze the failure of pressure vessels and safety measures taken for avoiding failure	**a,b,c,d,e,i,k,l**	
4.0	To study the buckling and fracture analysis in vessels	**4.1**	Determine the stresses in pressure vessels to design the system.	**a,b,c,d,e,i,k,l**	
5.0	To learnt piping layout and piping stress analysis	**5.1**	To create the flow diagram and layout of piping with consideration of stress and thermal analysis.	**a,b,c,d,e,i,k,l**	

UNIT I : INTRODUCTION	**(9)**
Methods for determining stresses - Terminology and Ligament Efficiency - Applications.	
UNIT II : STRESSES IN PRESSURE VESSELS	**(9)**
Introduction - Stresses in a circular ring, cylinder - Membrane stress Analysis of Vessel Shell components - Cylindrical shells, spherical Heads, conical heads - Thermal Stresses - Discontinuity stresses in pressure vessels.	
UNIT III : DESIGN OF VESSELS	**(9)**
Design of Tall cylindrical self-supporting process columns - supports for short vertical vessels - stress concentration - variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement - pressure vessel Design.	
UNIT IV : BUCKLING AND FRACTURE ANALYSIS IN VESSELS	**(9)**
Buckling phenomenon - Elastic Buckling of circular ring and cylinders under external pressure - collapse of thick walled cylinders or tubes under external pressure - Effect of supports on Elastic Buckling of Cylinders - Buckling under combined External pressure and axial loading.	
UNIT V : PIPING	**(9)**
Introduction - Flow diagram - Piping layout and piping stress analysis.	
TOTAL : L: 45 = 45 PERIODS	

REFERENCES:

1. John F. Harvey, "Theory and Design of Pressure Vessels", CBS Publishers and Distributors, 1987.
2. Henry H. Bedner, "Pressure Vessels, Design Hand Book", CBS publishers and Distributors, 1987.
3. Stanley, M. Wales, "Chemical process equipment, selection and Design", Buter worths series in Chemical Engineering, 1988.
4. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997.

17EDX16 DESIGN OF HEAT EXCHANGERS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To build the necessary background for the design of the various types of heat exchangers.	**1.1**	Apply the concepts and knowledge get to design and analyze the sizing and rating of the heat	**a,b,c,d,e,i,k,l**	
2.0	To learn the thermal and stress analysis on various parts of the heat exchangers.	**2.1**	Calculate the efficiency of heat exchanger.	**a,b,c,d,e,i,k,l**	
3.0	To learn the sizing of heat exchangers, thermal and mechanical stress analysis for various heat exchange applications.	**3.1**	Analyze heat transfer depending on nature of problem and available data	**a,b,c,d,e,i,k,l**	
4.0	To impart knowledge on compact and plate heat exchangers	**4.1**	Process the design of plate heat exchanger.	**a,b,c,d,e,i,k,l**	
5.0	To improve the design knowledge in condensers & cooling towers	**5.1**	Ability to design and analyze the performance of the condensers and cooling towers.	**a,b,c,d,e,i,k,l**	

UNIT I : FUNDAMENTALS AND CLASSIFICATION OF HEAT EXCHANGER	**(9)**
Parallel flow, Counter flow and cross flow; shell and tube and plate type; single pass and multi pass, once through stream generators etc.	
UNIT II : PROCESS DESIGN OF HEAT EXCHANGERS	**(9)**
Heat transfer correlations, Overall heat transfer coefficient, LMTD, sizing of finned tube heat exchangers, U tube heat exchangers, fouling factors, pressure drop calculations.	
UNIT III : MECHANICAL DESIGN OF SHELL AND TUBE TYPE	**(9)**
Thickness calculations, Tube sheet design using TEMA formula, Concept of equivalent plate for analyzing perforated analysis, flow induced vibration risks including acoustic issue and remedies, tube to tube sheet joint design, buckling of tubes, thermal stresses	
UNIT IV : COMPACT AND PLATE HEAT EXCHANGERS	**(9)**
Types - merits and demerits - design of compact heat exchangers, plate heat exchangers - performance influencing parameters, limitations.	
UNIT V : CONDENSERS & COOLING TOWERS	**(9)**
Design of surface and evaporative condensers - cooling tower - performance characteristics.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. J.P.Gupta, Fundamentals of Heat exchanger and pressure vessels technology, Hemisphere publishing corporation, springer -Verlag (outside NA), 1986
2. P Arthur Frass, Heat Exchanger Design, John Wiley & Sons,1988.

3. SadikKakac, Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press, 2002.
4. Hewitt.G.F,Shires.G.L,Bott.T.R, Process Heat Transfer, CRC Press,1994.
5. Taborek.T, Hewitt.G.F and Afgan.N, Heat Exchangers Theory and Practice, McGraw-Hill Book Co.1980
6. E.A.D. Sanders, Heat Exchangers, Selection Design and Construction Layman Scientific and Technical; co Published with John Wiley & Sons, 1988

17EDX17 PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING					
			L	T	P	C
			3	0	0	3
PREREQUISITE : 17EDA02					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To integrate the concepts of productivity models, organization transformation and Re-engineering process.	**1.1**	Apply the productivity improvement concepts in industries.	**a,b,d,e,i,k,l**	
2.0	To know the system approach to productivity measurement.	**2.1**	Familiar with all aspect of reengineering tools	**a,b,d,e,i,k,l**	
3.0	To acquaint students with the organizational transformation and re-engineering	**3.1**	Apply the re-engineering tools and techniques for performance improvement.	**a,b,d,e,i,k,l**	
4.0	Apply the knowledge to re-engineering process improvement models	**4.1**	Understand the process tool technology in re-engineering.	**a,b,d,e,i,k,l**	
5.0	To impart knowledge at re-engineering tools and implementation of reengineering projects	**5.1**	Implementation of reengineering projects in commercial purpose.	**a,b,d,e,i,k,l**	

UNIT I: PRODUCTIVITY	**(9)**
Productivity - Factor affecting productivity - Productivity benefit model - Productivity Cycle - Productivity Measurement at International, National and Industrial level.	
UNIT II : PRODUCTIVITY PLANNING IN ORGANIZATIONS	**(9)**
Productivity planning: Importance - Short term versus long term - Responsibilities - Weighted partial productivity- Production evaluation tree - Long term - Total Productivity maximization model - Total Productivity Profit model.	
UNIT III : ORGANIZATIONAL TRANSFORMATION	**(9)**
Principles of organizational transformation and re-engineering - Six R'S of organizational transformation and reengineering - fundamentals of process re-engineering - Preparing the workforce for transformation and reengineering - Principle & methodology- Guidelines - LMI CIP Model.	
UNIT IV : RE-ENGINEERING PROCESS IMPROVEMENT MODELS	**(9)**
PMI models, Moen and Nolan Strategy for process improvement, LMICIP personal improvement model- NPRDC process improvement model.	
UNIT V : RE-ENGINEERING TOOLS AND IMPLEMENTATION	**(9)**
Analytical and process tools and techniques - Information and Communication Technology - Implementation of Reengineering Projects - Success Factors and common implementation Problem - Case studies.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Sumanth, D.J., "Productivity Engineering and Management", TMH, New Delhi, 2007.
2. Edosomwan, J.A., "Organisational Transformation and Process Re-engineering", Library Catalog 1995.
3. Rastogi, P.N., "Re-engineering and Re-inventing the Enterprise", Wheeler Pub. New Delhi, 1995.
4. Premvrat, Sardana, G.D. and Sahay, B.S., "Productivity Management – A Systems Approach", Narosa Publishing House. New Delhi, 1998.

17EDX18 DESIGN FOR INTERNET OF THINGS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To integrate the concepts of Machine to Machine (M2M) to IoT	**1.1**	Understand the vision of IoT from a global context.	**a,b,e,i,k,l**	
2.0	To know the devices in IoT market perspective technology	**2.1**	Determine the market perspective of IoT.	**a,b,e,i,k,l**	
3.0	To learnt concepts of IoT networking	**3.1**	Understand the use of devices, gateways and IoT networking.	**a,b,e,i,k,l**	
4.0	To impart knowledge on state of art IoT architecture	**4.1**	Build state of the art architecture in IoT.	**a,b,e,i,k,l**	
5.0	To know the Integrating of architecture modeling and industrial automation	**5.1**	Apply of IoT in an industrial and commercial building automation and real world design constraints.	**a,b,e,i,k,l**	

UNIT I: INTRODUCTION	**(9)**
Machine to Machine (M2M) to IoT- vision-introduction, from M2M to IoT, M2M towards IoT- global context, A use case example, differing characteristics.	
UNIT II : IoT STRUCTURE	**(9)**
M2M to IoT - A Market Perspective - Introduction, some definitions, M2M value chains, IoT value chains, an emerging industrial structure for IoT, international driven global value chain and global information monopolies. **M2M to IoT- An Architectural Overview** - Building an architecture, main design principles and needed capabilities, IoT architecture outline, standards considerations.	
UNIT III : IoT NETWORKING	**(9)**
M2M and IoT Technology Fundamentals - Devices and gateways, local and wide area networking, data management, business processes in IoT, everything as a service (XaaS), M2M and IoT analytics, knowledge management.	
UNIT IV : IoT ARCHITECTURE	**(9)**
IoT Architecture - State of the Art - Introduction, State of the art, **Architecture Reference Model** - Introduction, reference model and architecture, IoT reference model.	
UNIT V : ARCHITECTURE MODELING	**(9)**
IoT Reference Architecture - Introduction, Functional view, Information view, deployment and operational view, other relevant architectural views. **Real-World Design Constraints** - Introduction, technical design constraints-hardware is popular again, data representation and visualization, Interaction and remote control. **Industrial Automation** - service - oriented architecture-based device integration, **SOCRADES:** realizing the enterprise integrated web of things, **IMC-AESOP:** from the web of things to the cloud of things, **Commercial Building Automation** - Introduction, case study: phase one-commercial building automation today, case study: phase two- commercial building automation in the future.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st ed , A press Publications, 2013.
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st ed , Academic Press, 2014.
3. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st ed , VPT, 2014.

17EDX19 DESIGN FOR SIX SIGMA					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To gain insights about the importance of lean manufacturing and six sigma practices	**1.1**	Understand Six Sigma Methodology and how it applies to their day-to-day work.	**a,b,c,d,e,i,k,l**	
2.0	To gain knowledge of improving define phase in production process	**2.1**	Relate the tools and techniques of lean sigma to increase productivity.	**a,b,c,d,e,i,k,l**	
3.0	To gain knowledge of humanizing measure and analysis phase.	**3.1**	Familiar with methodology to produce products with minimum wastages and maximum Productivity	**a,b,c,d,e,i,k,l**	
4.0	To impart knowledge on design phase of six sigma	**4.1**	Get familiarized in six sigma.	**a,b,c,d,e,i,k,l**	
5.0	To impart knowledge on validate phase	**5.1**	Ability to create the control chart, analysis performance with Simulation	**a,b,c,d,e,i,k,l**	

UNIT I : INTRODUCTION TO SIX SIGMA	**(9)**
Introduction to Six sigma, Project charter, PPM calculator, Gauge R&R , Linear Regression, One / Two way ANOVA, Assembly toleranceing, Basic Control charts, Case studies.	
UNIT II : DEFINE PHASE	**(9)**
Customer CTQ, QFD, Standardization, Reactive design to Predictive design quality.	
UNIT III : MEASURE & ANALYSE PHASE	**(9)**
Decomposition, Principal compound methods, Statistical distributions (non parametric), FMECA (Quantitative model), Reliability (Non normal), Availability, Maintainability (log normal), Risk assessment, Warranty prediction, QCF.	
UNIT IV : DESIGN PHASE	**(9)**
Generate and validate system / sub system models (Field trials), Identifying transfer function, Score cards, Design robustness – Taguchi SN ratio's, Error proofing.	
UNIT V : VALIDATE PHASE	**(9)**
Predicting process performance with Simulation, Testing a design, Statistically confirm build compare Predictions, Supplier - Manufacturing control plans for mean and variance, control charts, Piloting a design.	
TOTAL : L: 45 = 45 PERIODS	

REFERENCES:

1. Statistical and Managerial Techniques for Six Sigma Methodology, Stefano Barone University of Palermo, Italy and Chalmers University of Technology, Sweden Eva Lo Franco University of Palermo, Italy,1st ed , 2012.
2. Six Sigma for Organizational Excellence, K. Muralidharan, 2015.
3. Six Sigma Demystified, Paul Keller, 2005
4. Six sigma for Dummies, Craig Gygi and Bruce Williams with Neil DeCarlo, John Wiley & Sons, Inc. 2nd ed , 2012.

17EDX20 ADVANCED STRENGTH OF MATERIALS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : 17EDB01					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand the deformation of bodies under the different loads	**1.1**	Apply the failure theory concepts, while designing products	**a,e,l**	
2.0	To understand dynamics of stresses in various sections	**2.1**	Gain knowledge about stress distribution	**a,b,e,l**	
3.0	To familiarize the students in the curved flexible members and stresses in flat plates	**3.1**	Explain the types of stresses in flat plates	**a,b,e,l**	
4.0	To solve problems involving torsion of noncircular sections	**4.1**	Calculate the torsion and stresses in sections used in various applications	**a,b,e,l**	
5.0	To solve problems involving radial and tangential stresses and contact stresses.	**5.1**	Demonstrate the knowledge of radial and tangential stresses in solid disc	**a,e,l**	

UNIT I : ELASTICITY	**(9)**
Stress, stress tensor, stress concentration factor, stress strain relation and general equation of elasticity in cartesion, polar and spherical coordinates, differential equations of equilibrium - compatibility - boundary conditions - representation of three - dimensional stress of a tension generalized hook's law - St. Venant's principle - plane stress - Airy's stress function. Energy methods.	
UNIT II : SHEAR CENTER AND UNSYMMETRICAL BENDING	**(9)**
Location of shear center for various thin sections - shear flows. Stresses and deflections in beams subjected to unsymmetrical loading - kern of a section.	
UNIT III : CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES	**(9)**
Curved flexible members, circumference and radial stresses - deflections - curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular plates - pure bending of plates - deflection - uniformly distributed load - various end conditions.	
UNIT IV : TORSION OF NON-CIRCULAR SECTIONS	**(9)**
Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy Prandtl's stress function torsional stress in hollow thin wall tubes.	
UNIT V : STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES	**(9)**
Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness with allowable speeds - Methods of computing contact stress - Deflection of bodies in point and line contact applications.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Arthur P Boresi, Richard J. Schmidt, “Advanced Mechanics of Materials”, John Wiley, 2002.
2. G H Ryder, “Strength of Materials”, Macmillan, India Ltd, 2007.
3. Timoshenko and Goodier, “Theory of Elasticity”, McGraw Hill, 1970.
4. Robert D. Cook, Warren C. Young, “Advanced Mechanics of Materials”, Mc- Millan pub. Co., 1985.
5. Srinath. L.S., “Advanced Mechanics of Solids”, Tata McGraw Hill, 1992.

17EDX21 TRIBOLOGY IN DESIGN					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To provide greater insight into the science and technology of interacting surfaces in relative motion	**1.1**	Select material / surface properties based on the tribological requirements	**a,b,f,k,l**	
2.0	To impart knowledge in the friction, wear and lubrication aspects of machine components	**2.1**	Get Methodology for deciding lubricants and lubrication regimes for different operating conditions	**a,b,c,d,e,f,k,l**	
3.0	To understand the analytical behavior of different types of bearings and design of bearings based on analytical /theoretical approach	**3.1**	Get Analysis ability of different types of bearings for given load/ speed conditions.	**a,b,c,d,e,f,k,l**	
4.0	To provide greater insight into the science and technology of interacting surfaces in relative motion.	**4.1**	Understand the fundamental principles of thermo hydrodynamic lubrication to determine the temperature distribution in the lubricant film under variable viscosity conditions.	**a,b,c,d,e,f,k,l**	
5.0	To give detailed study of contact mechanics and tribo measurements	**5.1**	Familiar with mathematical tools used to analyze tribological processes	**a,b,c,d,e,f,k,l**	

UNIT I : SURFACE INTERACTION AND SURFACE TREATMENT	**(9)**
Topography of Surfaces - Surface features - Properties and Measurement - Surface interaction - Surface treatments - Surface modifications - surface coatings methods- Surface Topography measurements - Laser methods - instrumentation - International standards in friction and wear measurements	
UNIT II : WEAR AND FRICTION	**(9)**
Types of wear - Mechanism of various types of wear - Laws of wear -Theoretical wear models - Wear of Metals and Non metals - Adhesive theory of sliding friction - Rolling friction - Friction properties of metallic and Non-Metallic Materials - Friction in extreme conditions - Thermal considerations in sliding contact	
UNIT III : LUBRICANTS AND LUBRICATION REGIMES	**(9)**
Lubricants and their physical properties - Viscosity and other properties of oils – Additives - Selection of Lubricants - Lubricants standards ISO,SAE,AGMA, BIS standards - Lubrication Regimes - Solid Lubrication- Dry and marginally lubricated contacts- Boundary Lubrication - Hydrodynamic lubrication - Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication - Hydro static lubrication - Gas lubrication.	
UNIT IV : THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION	**(9)**
Reynolds Equation,- Assumptions and limitations-One and two dimensional Reynolds Equation - Reynolds and Somerfield boundary conditions - Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings - Long and short bearings - Pad bearings and Journal bearings-Squeeze film effects -Thermal considerations - Hydrostatic lubrication of Pad bearing - Pressure , flow , load and friction calculations - Stiffness considerations- Various types of flow restrictors in hydrostatic bearings.	

UNIT V : CONTACT MECHANICS AND TRIBO MEASUREMENTS	(9)
Contact mechanics, Analysis of contacts, Elastic plastic contact of frictionless solids, problems. Bearing torque calculation, temperature analysis, endurance testing and failure analysis, bearing performance measurements, bearing vibration measurements.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
2. S.K.Basu, S.N.Sengupta, B.B.Ahuja, “Fundamentals of Tribology”, Prentice–Hall of India Pvt. Ltd., New Delhi, 2005
3. B.C Majumdar, “Introduction to Tribology of bearings”, S. Chand and company Ltd., New Delhi 2008.
4. Prasanta Sahoo, “Engineering Tribology”, Prentice Hall of India, New Delhi 2005.
5. Rabinowicz.E, “Friction and Wear of materials”, John Willey & Sons,UK,1995
6. Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981
7. Halling, J. (Editor) – “Principles of Tribology”, Macmillian, 1984.
8. G.W.Stachowiak, A.W .Batchelor, “Engineering Tribology”, Butterworth-Heinemann, UK, 2005

17EDX22 NANOMATERIALS AND NANO TECHNOLOGY					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To impart knowledge on the general issues relating to nanotechnology and nano fabrication.	**1.1**	Acquire the knowledge of the representatives of nano particles and feature techniques of NM	**a,b,c,e,l**	
2.0	To impart knowledge on the methods for 2-D nanostructures	**2.1**	Familiar with new trends in engineering, namely nanotechnology and nanofabrication and with their applications in modern industries.	**a,b,c,e,l**	
3.0	To give detailed study of nanomechanics and nano electronics	**3.1**	Get knowledge in the field of nano technology and nano materials	**a,b,c,e,l**	
4.0	To get a basic understanding of the nanoscale heat transfer and nanophotonics	**4.1**	Know about mode of heat transfer in nanoparticles and nanomaterials	**a,b,c,e,l**	
5.0	To study the fluids at the nano scale	**5.1**	Understanding nanoscale of fluids and applications of nanofluids	**a,b,c,e,l**	

UNIT I : ZERO – DIMENSIONAL NANOSTRUCTURES AND 1 D NANOSTRUCTURE- NANOWIRES AND NANORODS	**(10)**
Nanoparticles through homogenous nucleation, nanoparticles through the heterogeneous nucleation, kinetically confined synthesis of nanoparticles, epitaxial core - shell nanoparticles. Spontaneous growth, template based synthesis, electro spinning, and lithography.	
UNIT II : 2-D NANOSTRUCTURES - THIN FILMS AND NANOSTRUCTURES FABRICAITON	**(10)**
Fundamentals of film growth, vacuum science, Physical vapor deposition (PVD), Chemical vapor deposition (CVD), Atomic layer deposition (ALD), Electrochemical deposition, Sol-Gel films. Lithography, nano manipulation and nanolithography, soft lithography, assembly of nanoparticles and nanowires, other methods of micro fabrication.	
UNIT III : NANOMECHANICS AND NANO ELECTRONICS	**(10)**
A high speed review of motion: Displacement, velocity, acceleration and force, nano mechanical oscillation, feeling faint forces. Electron energy bands, electrons in solids: conductors, insulation and semi-conductors, fermi energy, the density of states for solids, quantum confinement, tunneling, single electron phenomenon, molecular electronics.	
UNIT IV : NANOSCALE HEAT TRANSFER AND NANOPHOTONICS	**(10)**
Nanoscale heat, conduction, convection, radiation. Photonics properties of nano materials, near - field light, optical tweezers, photonic crystals.	
UNIT V : NANOSCALE FLUID MECHANICS	**(5)**
Fluids at the nanoscale: major concepts, flow fluids flow at the nanoscale, applications of nanofluids.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Bhushan, Bharat (Ed.) Handbook of Nanotechnology, Springer 2006.
2. Guozhong Cao, Nanostructures and Nanomaterials, Imperial College Press, 2006.

3. Ben Rogers, Pennathur and Adams, Nanotechnology: Understanding Small System, CRC Press, 2008.
4. Yury Gogotsi, Nanomaterials Handbook, Drexel University, Philadelphia, Pennsylvania, USA, 2006.
5. Lundstrom, Mark, Guo, Jing, Nanoscale transistors, Device physics, modeling and simulation, Springer, 2006.

17EDX23 MICRO ELECTRO MECHANICAL SYSTEMS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To impart knowledge on MEMS and manufacturing techniques	**1.1**	Gain knowledge about MEMS and Microsystems	**a,b,c,e,l**	
2.0	To get an exposure on the materials for MEMS and micro systems	**2.1**	Familiarize with the materials used in MEMS and micro systems	**a,b,c,e,l**	
3.0	To create exposure to packaging techniques of micro system fabrication processes	**3.1**	Choosing the suitable fabrication technique processes.	**a,b,c,e,l**	
4.0	To impart knowledge on micro manufacturing processes	**4.1**	Apply knowledge of micro manufacturing techniques and applications to the design and manufacturing of an MEMS device or a micro system	**a,b,c,e,l**	
5.0	To educate the influence of micro system packaging	**5.1**	Understand the unique selection of packaging materials of MEMS	**a,b,c,e,l**	

UNIT I : INTRODUCTION	**(9)**
Introduction to MEMS and Microsystems - Typical MEMS and Micro system products - Microsystems and micro electronics - Applications of Microsystems in automotive and other industries - Microsensors - Acoustic wave sensors, Bio medical sensors - Optical sensors, Pressure sensors - Micro actuators - Micro grippers, Micro motors, Micro valves, Micro pumps.	
UNIT II : MATERIALS FOR MEMS AND MICROSYSTEMS	**(9)**
Substrates and Wafers - Active substrate materials - Silicon as a substrate material - Silicon compounds - Silicon Dioxide, Silicon Carbide, Silicon Nitride, Polycrystalline Silicon - Silicon Piezoresistors - Gallium Arsenide - Quartz - Polymers - Polymers as Industrial Materials, Polymers for MEMS and Microsystems, Conductive Polymers - Packaging Materials	
UNIT III : MICROSYSTEM FABRICATION PROCESSES	**(9)**
Introduction - Principle of corrosion - Classification of corrosion - Types of corrosion - Factors influencing corrosion - Testing of corrosion - In-service monitoring, Simulated service, Laboratory testing - Evaluation of corrosion - Prevention of Corrosion - Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.	
UNIT IV : MICRO MANUFACTURING	**(9)**
Bulk Micro manufacturing - Etching - Isotropic and Anisotrotpic etching, Wet etching, Dry etching - Surface micromachining - General process, Mechanical problems associated with surface micromachining - LIGA Process-general Process, Materials for substrates and photo resists - Electroplating - SLIGA Process.	
UNIT V : MICROSYSTEM PACKAGING	**(9)**
Mechanical packaging of microelectronics – Micro system packaging - General considerations, Three levels of micro system packaging - Interfaces in micro system packaging - Essential packaging technologies – Die preparation, Surface bonding, Wire bonding - Three dimensional packaging - Assembly of microsystems - Selection of packaging materials.	
	TOTAL : L: 45 = 45 PERIODS

REFERENCES:

1. Tai-Ran Hsu, “MEMS & Microsystems Design and Manufacture”, McGraw Hill Education, 2010

2. N.P.Mahalik, “MEMS”, McGraw-Hill Companies, 2010.
3. Gardner, W. Julian, K. Varadan Vijay and O. Awadelkarim, Osama, “Micro sensors MEMS and Smart Devices”, Jhon Wiley & Sons Ltd, 2001.
4. Gad-el-Hak, Mhamed, The MEMS Handbook, CRC Press, 2002.

17EDX24 SURFACE ENGINEERING					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To impart knowledge on surface modification methods that will come in handy to solve the industrial problems.	**1.1**	Demonstrate the knowledge on friction for various surfaces	**a,b,c,e,k,l**	
2.0	To give the wear knowledge about surface engineering	**2.1**	Describe the International standards in friction and wear measurements.	**a,b,c,e,k,l**	
3.0	To give the corrosion knowledge about surface engineering	**3.1**	Identify the types and classification of corrosion for various surfaces	**a,b,c,e,k,l**	
4.0	To acquaint students with the tool concepts for surface treatment	**4.1**	Explain the procedures in various surface treatment process	**a,b,c,e,k,l**	
5.0	This will also serve as a precursor for future research in the engineering materials field.	**5.1**	Summarize the steps involved in engineering material sand to solve the industrial practical problems that arise and also for the research.	**a,b,c,e,k,l**	

UNIT I : FRICTION	**(9)**
Topography of surfaces - Surface features - Properties and measurement - Surface interaction - Adhesive theory of sliding friction - Rolling friction - Friction properties of metallic and nonmetallic materials - Friction in extreme conditions - Thermal considerations in sliding contact.	
UNIT II : WEAR	**(9)**
Introduction - Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear - Laws of wear - Theoretical wear models - Wear of metals and non metals - International standards in friction and wear measurements.	
UNIT III : CORROSION	**(9)**
Introduction - Principle of corrosion - Classification of corrosion - Types of corrosion - Factors influencing corrosion - Testing of corrosion - In-service monitoring, Simulated service, Laboratory testing - Evaluation of corrosion - Prevention of corrosion - Material selection, Alteration of environment, Design, Cathodic and Anodic protection, Corrosion inhibitors.	
UNIT IV : SURFACE TREATMENT	**(9)**
Introduction - Surface properties, Superficial layer - Changing surface metallurgy – Wear resistant coatings and Surface treatments - Techniques - PVD - CVD - Physical CVD - Ion implantation - Surface welding - Thermal spraying - Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control - Characteristics of Wear resistant coatings - New trends in coating technology - DLC - CNC - Thick coatings - Nano - engineered coatings - Other coatings, Corrosion resistant coatings.	
UNIT V : ENGINEERING MATERIALS	**(9)**
Introduction - Advanced alloys - Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys - Ceramics - Polymers - Biomaterials - Applications - Bio tribology - Nano tribology.	
TOTAL : L: 45 = 45 PERIODS	

REFERENCES:

1. G.W.Stachowiak & A.W .Batchelor , “Engineering Tribology”, Butterworth-Heinemann, UK,2005
2. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons,UK,1995
3. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.
4. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005

17EDX25 ENGINEERING FRACTURE MECHANICS					
		L	T	P	C
		3	0	0	3
PREREQUISITE : 17EDB02					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To provide knowledge on elements of solid mechanics.	**1.1**	Gain knowledge on stationary crack, crack growth and fatigue crack growth.	**a,l**	
2.0	To understand the crack growth and energy balance.	**2.1**	Analyze crack growth for cyclic loading and crack initiation under large scale.	**a,b,e,l,k**	
3.0	To study the analysis of energy balance and crack growth mechanics	**3.1**	Analyze the different effects of cracks, thermal and residual stresses.	**a,b,c,e,l,k**	
4.0	To understand the working principle and analysis of fatigue crack	**4.1**	Gain knowledge about the behavior of engineering materials having microscopic flaws, learning the component design methods in fracture mechanics taking fracture toughness into account.	**a,b,c,d,e,l**	
5.0	To study the applications of fracture mechanics.	**5.1**	Learning the application of fracture mechanics in large scale yielding	**a,b,c,l**	

UNIT I : ELEMENTS OF SOLID MECHANICS	**(9)**
The geometry of stress and strain, elastic deformation, plastic and elastic-plastic deformation - limit analysis.	
UNIT II : STATIONARY CRACK UNDER STATIC LOADING	**(9)**
Two dimensional elastic zone fields - Analytical solutions yielding near a crack front - Irwin's approximation - Plastic zone size - Dugdaale model -J integral and its relation to crack opening development.	
UNIT III : ENERGY BALANCE AND CRACK GROWTH	**(9)**
Griffith analysis - Linear fracture mechanics -Crack opening displacement - Dynamic energy balance - Crack arrest.	
UNIT IV : FATIGUE CRACK GROWTH CURVE	**(9)**
Empirical Relation describing crack growth by fatigue - life calculations for a given load amplitude - effects of changing the load spectrum - Effects of Environment.	
UNIT V : APPLICATIONS OF FRACTURE MECHANICS	**(9)**
Crack Initiation under large scale yielding - thickness as a design parameter - mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods.	
TOTAL : L : 45 = 45 PERIODS	

REFERENCES:

1. Tribikram Kundu, "Fundamentals of Fracture Mechanics", ANE Books Pvt. Ltd. New Delhi / CRC Press, 1st Indian Reprint, 2012
2. David Broek, "Elementary Engineering Fracture Mechanics", Fifthoff and Noerdhoff International Publisher, 1978.
3. Kare Hellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 1985.
4. Preshant Kumar, "Elements of Fracture Mechanics", Wheeler Publishing, 1999.

17EDX26 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To impart the design concepts	**1.1**	Understand the robot kinematics and dynamics.	**a,b,c,e,f,k,l**	
2.0	To create expertise in various drive systems of robot.	**2.1**	Acquire the ability to write basic program to control robot.	**a,b,c,e,f,k,l**	
3.0	To ensure that the student has thorough conceptual understanding of robot sensors.	**3.1**	Gain knowledge about sensors used in robotics field.	**a,b,c,d,e,f,k,l**	
4.0	This course provides an in-depth coverage of the central topics in robot cell design	**4.1**	Summarize the stages in robot dell design	**a,b,c,d,e,f,k,l**	
5.0	To give the student knowledge about robot programming, and expert systems	**5.1**	Explain the steps involved in robot programming	**a,b,c,d,e,f,k,l**	

UNIT I : INTRODUCTION AND ROBOT KINEMATICS	**(9)**
Definition need and scope of Industrial robots - Robot anatomy - Work volume - Precision movement - End effectors - Sensors. Robot Kinematics - Direct and inverse kinematics - Robot trajectories - Control of robot manipulators - Robot dynamics - Methods for orientation and location of objects.	
UNIT II : ROBOT DRIVES AND CONTROL	**(9)**
Controlling the Robot motion - Position and velocity sensing devices - Design of drive systems - Hydraulic and Pneumatic drives - Linear and rotary actuators and control valves - Electro hydraulic servo valves, electric drives - Motors - Designing of end effectors - Vacuum, magnetic and air operated grippers. .	
UNIT III : ROBOT SENSORS	**(9)**
Transducers and Sensors - Tactile sensor - Proximity and range sensors - Sensing joint forces - Robotic vision system - Image Representation - Image Grabbing - Image processing and analysis - Edge Enhancement - Contrast Stretching - Band Rationing - Image segmentation - Pattern recognition - Training of vision system.	
UNIT IV : ROBOT CELL DESIGN AND APPLICATION	**(9)**
Robot work cell design and control - Safety in Robotics - Robot cell layouts - Multiple Robots and machine interference - Robot cycle time analysis - Industrial application of robots.	
UNIT V: ROBOT PROGRAMMING, AI AND EXPERT SYSTEMS	**(9)**
Methods of robot programming - Characteristics of task level languages - lead through programming methods - Motion interpolation. Artificial intelligence - Basics - Goals of artificial intelligence - AI techniques - problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.	
TOTAL : L: 45 = 45 PERIODS	
REFERENCES:	
1. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, “Industrial Robotics Technology, Programming and Applications”, McGraw-Hill Int. 1986.	

2. Deb, S.R. “Robotics Technology and Flexible Automation”, Tata McGraw-Hill, 1994.
3. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987.
4. YoramKoren, “Robotics for Engineers”, McGraw-Hill, 1987.
5. Kozyrey, Yu. “Industrial Robots”, MIR Publishers Moscow, 1985.

17EDX27 PRODUCT LIFECYCLE MANAGEMENT					
			L	T	P	C
			3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**		**Related Program outcomes**	
1.0	To understand history, concepts and terminology of PLM	**1.1**	Understand history, concepts and terminology of PLM.	**a,b,d,e,f,g,i,k,l**	
2.0	To understand functions and features of PLM/PDM	**2.1**	Apply the functions and features of PLM/PDM.	**a,b,d,e,f,g,i,k,l**	
3.0	To understand different modules offered in commercial PLM/PDM tools	**3.1**	Understand different modules offered in commercial PLM/PDM tools.	**a,b,d,e,f,g,i,k,l**	
4.0	To understand PLM/PDM implementation approaches	**4.1**	Understand PLM/PDM implementation approaches.	**a,b,d,e,f,g,i,k,l**	
5.0	To understand integration of PLM/PDM with other applications	**5.1**	Integrate PLM/PDM with other applications.	**a,b,d,e,f,g,i,k,l**	

UNIT I : HISTORY, CONCEPTS AND TERMINOLOGY OF PLM	**(9)**
Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure -Network and Communications, Data Management, Heterogeneous data sources and applications.	
UNIT II : PLM/PDM FUNCTIONS AND FEATURES	**(9)**
User Functions - Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions - Communication and Notification, data transport, data translation, image services, system administration and application integration.	
UNIT III : DETAILS OF MODULES IN A PDM/PLM SOFTWARE	**(9)**
Case studies based on top few commercial PLM/PDM tools	
UNIT IV : ROLE OF PLM IN INDUSTRIES	**(9)**
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance.	
UNIT V : BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE	**(9)**
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP	
TOTAL : L: 45 = 45 PERIODS	

REFERENCES:

1. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
4. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
5. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
6. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

17BAZ01- RESEARCH METHODOLOGY				
L	T	P	C	
3	0	0	3	

PREREQUISITE: NIL

COURSE OBJECTIVES AND OUTCOMES:

Course Objectives		Course Outcomes		Program outcomes
1.0	To understand the basic concepts of research and its methodologies, sources of information for literature review	**1.1**	Demonstrate the concepts of research and its methodologies, sources of information for literature review	**a,c,d,e,f,g,h,j,k,l**
2.0	To identify the various procedures to formulate appropriate research design, data collection and measurement.	**2.1**	Formulate appropriate research design, data collection and conduct the experiments using systematic methods.	**a,b,c,e,f,g,h,i,k,l**
3.0	To summarize various methods for data preparation and analysis	**3.1**	Identify the design for coding, editing and analysis of data	**b,c,d,e,f,g,h,i,j,k**
4.0	To provide knowledge of report types, report writing and guidelines to review report	**4.1**	Choose the process like drawing and drafting tools and reviewing research papers	**c,d,e,f,g,h,i,j,k,l**
5.0	To summarize the Intellectual property rights and Ethics in research	**5.1**	Formulate the design for Intellectual property rights and code of ethics	**b,c,d,e,f,h,i,j,k,l**

UNIT I : INTRODUCTION	**(7)**
Research methodology - Understanding the language of research – Concepts, constructs, operational definitions, variables, propositions, hypotheses, theories, and models - Research process- Literature review -Types of research.	
UNIT II : RESEARCH DESIGN, DATA COLLECTION AND MEASUREMENT	**(10)**
Problem identification and formulation - Research question – Research hypothesis - Measurement issues - Methods of data collection Types of data- Primary data- Scales of measurement- Sources and collection of data Observation method- Interview method– Survey- Experiments- Secondary data-Research design- Qualitative and Quantitative Research.	
UNIT III : DATA PREPARATION AND ANALYSIS	**(10)**
Processing and analysis of data- Sampling- Steps and characteristics of sampling design Sampling: concepts of Population, Sample, Sampling Frame, - Sample size and its determination - Types of sampling distributions - Sampling error - Statistics in research Descriptive statistics and inferential statistics- Measures of central tendency, dispersion, skewness, asymmetry- Measures of relationship- Correlation and regression- Simple regression analysis- Multiple regression -Hypothesis Testing - parametric and non-parametric tests- Analysis of single factor experiments.	
UNIT IV : REPORT WRITING AND DESIGN	**(10)**
Reporting and presenting research - Written and oral communications -Hallmark of great scientific writing-The reading toolkit - Pre-writing considerations - Format of dissertations-Drawing and Drafting Tools, research reports, and research papers – Paper title and keywords – Writing an abstract – Writing the different sections of a paper - Revising a paper - Responding to peer reviews - Reviewing research papers - Plagiarism - Conference and poster presentations	

- Language aspects of report writing -Verb, tense and voice in scientific writing - Errors in grammar - Sentence and paragraph constructions -Paraphrasing - Measures of research impact.

UNIT V : INTELLECTUAL PROPERTY RIGHTS AND ETHICS IN RESEARCH	**(8)**

Intellectual property rights-Co-creation Methodology to make products from projects - Copyright - Patents - The codes of ethics - Avoiding the problems of biased survey -Occupational health and safety.

TOTAL : L: 45 = 45 PERIODS

REFERENCES:

1. Cooper, D. R. and Schindler, P. S., (2009), *Business Research Methods*, Tata McGraw Hill, 9th Edition.
2. Jackson, S.L., *Research Methods and Statistics*, Cengage Learning India Private Limited, New Delhi, 2009
3. Krishnaswamy, K.N., Sivakumar, A.I., and Mathirajan, M., *Management Research Methodology*, Pearson Education , 2006.
4. Lebrun, J-L., *Scientific Writing: A Reader and Writer's Guide*, World Scientific Publishing Co. Pte. Ltd., Singapore, 2007.
5. MLA, MLA *Handbook for Writers of Research papers*, Seventh Edition, Affiliated East West Press Pvt Ltd, New Delhi, 2009.
6. Thiel, D. V., *Research Methods for Engineers*, Cambridge University Press, 2014.

17CPZ01 MACHINE VISION					
		L	T	P	C
		3	0	0	3
PREREQUISITE: Basics of Computers					
COURSE OBJECTIVES AND OUTCOMES:					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To know the basics of machine vision and computer vision	**1.1**	The student will be able to apply the vision concepts in various mechatronics applications		**a,b,c,e,i,k,l**
2.0	To study the image acquisition techniques	**2.1**	The student will be able to recognize the Image acquisition techniques and tools		**a,b,c,e,i,k,l**
3.0	To learn the image processing methods	**3.1**	The student will be able to apply the image processing tools and libraries		**a,b,c,e,i,k,l**
4.0	To understand the methods used for image analysis	**4.1**	The student will be able to analyze the images in the case of Robotic or IoT applications		**a,b,c,e,i,k,l**
5.0	To gain exposure on Image processing applications	**5.1**	The student will be able to select the right machine vision system for implementing in industrial applications		**a,b,c,e,i,k,l**

UNIT I INTRODUCTION	**(8)**
Human vision – Machine vision and Computer vision – Benefits of machine vision – Blockdiagram and function of machine vision system implementation of industrial machine vision system – Physics of Light – Interactions of light – Refraction at a spherical surface	
UNIT II IMAGE ACQUISITION	**(12)**
Scene constraints – Lighting parameters – Lighting sources, Selection – Lighting Techniques – Types and Selection – Machine Vision Lenses and Optical Filters, Specifications and Selection Imaging Sensors – CCD and CMOS, Specifications – Interface Architectures – Analog andDigital Cameras – Digital Camera Interfaces – Camera Computer Interfaces, Specifications andSelection – Geometrical Image formation models – Camera Calibration	
UNIT III IMAGE PROCESSING	**(10)**
Machine Vision Software – Fundamentals of Digital Image – Image Acquisition Modes – ImageProcessing in Spatial and Frequency Domain – Point Operation, Thresholding, GrayscaleStretching – Neighborhood Operations, Image Smoothing and Sharpening – Edge Detection –Binary Morphology – Color image processing.	
UNIT IV IMAGE ANALYSIS	**(6)**
Feature extraction – Region Features, Shape and Size features – Texture Analysis – TemplateMatching and Classification – 3D Machine Vision Techniques – Decision Making.	
UNIT V MACHINE VISION APPLICATIONS	**(9)**
Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile,applications in non-visible spectrum, metrology and gauging, OCR and OCV, vision guidedrobotics – Field and Service Applications – Agricultural, and Bio medical field, augmentedreality, surveillance, bio-metrics.	
TOTAL :(L: 45) = 45 PERIODS	

REFERENCES:

1. D. A. Forsyth and J. Ponce, “Computer Vision: A Modern Approach”, Pearson Education, 2003.
2. R. Jain, R. Kasturi and B. G. Schunck, “Machine Vision”, McGraw-Hill, 1995.
3. Dana H. Ballard & Christopher M. Brown, “Computer Vision”, Prentice-Hall, 1982.
4. Alexander Hornberg, “Handbook of Machine Vision”, First Edition
5. EmanueleTrucco, Alessandro Verri, “Introductory Techniques For 3D Computer Vision”, First Edition

17EDX28 – QUALITY CONCEPTS IN DESIGN					
		L	T	P	C
		3	0	0	3
PREREQUISITE : NIL					
COURSE OBJECTIVES AND OUTCOMES :					
Course Objectives		**Course Outcomes**			**Related Program outcomes**
1.0	To study the knowledge on design for quality	**1.1**	Explain the concepts of Quality Function Deployment, design of experiments and experimental design.		**a,b,d,k,l**
2.0	Enable Students to attain knowledge on tools used in FMEA	**2.1**	Describe the modes of failure and its effects using FMEA process.		**a,b,d,f**
3.0	Create an understanding on the process of material selection and design	**3.1**	Apply design of experiments method and statistical analysis of experiments		**a,b,c,d**
4.0	Develop in depth knowledge on Engineering statistics and reliability	**4.1**	Use statistical techniques and statistical process control methods for constructing charts and concepts of reliability		**a,b,d,l**
5.0	Create awareness on legal and ethical issues in lean production	**5.1**	Employ SIX SIGMA concepts.		**a,b,c,**

UNIT I : DESIGN FOR QUALITY	**(9)**
Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders-Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics –developing the experimental plan- experimental design –testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points reflecting and repeating.	
UNIT II : MODES OF FAILURE AND ITS EFFECTS	**(9)**
Basic methods: Refining geometry and layout, general process of product embodiment- Embodiment checklist-Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling-Case study- computer monitor stand for a docking station.	
UNIT III : DESIGN OF EXPERIMENTS	**(9)**
Design of experiments-Basic methods- Two factorial experiments-Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design-Statistical analysis of experiments: Degree of freedom, correlation coefficient, standard error of the residual t-test, ANOVA-ratio test, other indicators-residual plots, Advanced DOE method for product testing- Product applications of physical modeling and DOE, Blender panel display evaluation, coffee grinder experimental optimization-Taguchi method.	
UNIT IV : STATISTICAL CONSIDERATION AND RELIABILITY	**(9)**
Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.- Reliability-Survival and Failure-Series and parallel systems-Mean time between failure-Weibull distribution	
UNIT V : DESIGN FOR SIX SIGMA	**(9)**
Basis of SIX SIGMA –Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production – Lean SIX SIGMA and services	
TOTAL (L: 45) = 45 PERIODS	

REFERENCES:

1. Product Design Techniques in Reverse Engineering and New Product Development, Kevin Otto & Kristin Wood, Pearson Education (LPE), 2001.
2. Product Design and Development, Karl T. Ulrich, Steven D. Eppinger, TATA McGraw-Hill - 3rd Edition, 2003.
3. The Management and control of Quality-6th edition-James R. Evens, William M Lindsay Pub:son south-western(www.swlearning.com)
4. Fundamentals of Quality control and improvement 2nd edition, Amitava Mitra,Pearson Education Asia, 2002