DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE & SYLLABUS FOR

R25 M.Tech (CAD/CAM) PROGRAM

(Applicable for batches admitted from 2025-2026)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

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DEPARTMENT OF MECHANICAL ENGINEERING

R25 M.TECH CAD CAM COURSE STRUCTURE AND SYLLABUS

M. Tech (CAD/CAM) **I –SEMESTER**

S.No	Course Code	Course Title		L	T	P	C
1	CA 101	Advanced Finite Element Methods		3	1	0	4
2	CA 102	Advanced CAD		3	1	0	4
	CA 103	AI & ML for Mechanical Engineering		3	1	0	4
3	Program Elective – I	CA 1041	Mechanical Behavior of Materials & Characterization	3	0	0	3
		CA 1042	Optimization and Reliability				
		CA 1043	Mechatronics				
		CA 1044	Computational Fluid Dynamics				
		CA 1045	NPTEL/SWAYAM MOOCs Course with 12 Weeks Duration				
4	Program Elective – II	CA 1051	MEMS: Design and Manufacturing	3	0	0	3
		CA 1052	Design for Manufacturing & Assembly				
		CA 1053	Fracture Mechanics				
		CA 1054	Smart Materials				
		CA 1055	NPTEL/SWAYAM MooCs Course with 12 Week Duration				
5	CA 106	Material Processing and Characterization Lab		0	0	4	2
6	CA 107	Advanced CAE Lab		0	0	4	2
7	CA 108	Seminar-I		0	0	2	1
		Total		**15**	**5**	**6**	**23**

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II –SEMESTER

S. No	Course Code	Course Title		L	T	P	C
1	CA 201	Robotics & UAV Systems		3	1	0	4
2	CA 202	Advanced Manufacturing Processes		3	1	0	4
	CA 203	Computer Aided Manufacturing		3	1	0	4
3	Program Elective– III	CA 2041	Precision Engineering	3	0	0	3
		CA 2042	Theory of Elasticity and Plasticity				
		CA 2043	Entrepreneurship & Design of Business Models				
		CA 2044	Additive Manufacturing				
			NPTEL/SWAYAM MooCs Course with 12 Week Duration				
4	Program Elective– IV	CA 2051	Introduction to Embedded systems	3	0	0	3
		CA 2052	Modeling and Simulation of Manufacturing Systems				
		CA 2053	Smart Manufacturing				
		CA 2054	Introduction to Quantum Technologies				
		CA 2055	NPTEL/SWAYAM MooCs Course with 12 Week Duration				
5	CA 206	Robotics & UAV Systems Lab		0	1	2	2
6	CA 207	Advanced CAM Lab		0	1	2	2
7	CA 208	Seminar-II		0	0	2	1
		Total		**15**	**5**	**6**	**23**

Note: Students are informed to complete Summer Internship (duration 8-10 weeks) at the end of the II Semester.

M. Tech (CAD/CAM) **III- SEMESTER**

S. No	Course Code	Course Title	L	T	P	C
1		Research Methodology and IPR/ Swayam 12 Week MOOC Course	3	0	0	3
2		Evaluation of Summer Internship/Industrial Training (8-10 Weeks)	-	-	-	3
3		Comprehensive Viva	-	-	-	2
4		Dissertation Part – A	-	-	20	10
TOTAL			3	-	20	18

IV –SEMESTER

S. No	Course Code	Course Title	L	T	P	C
1		Dissertation Part – B	-	-	32	16
TOTAL			-	-	32	16

I Semester	ADVANCED FINITE ELEMENT METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- The course's goal is to familiarise students with the fundamentals of the Finite Element Technique, a numerical method for solving various practical and the method's fundamentals will eventually be covered before moving on to various areas of implementation.
- To present analytical approaches for structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Apply several kinds of computational methods to develop and evaluate the governing equations for various engineering problem	K3& K5
CO2	Develop, solve, and analyse problems involving one-dimensional axially loaded bars, trusses, and beam elements	K3 &K4
CO3	Apply the numerical methods of FEM to derive element matrices. Solve and analyse two dimensional CST, axi-symmetric problems subjected to various boundary conditions	K3 & K4
CO4	Apply and develop the solutions for the numerous engineering problems using the concepts of iso-parametric formulation and convergence techniques	K3
CO5	Evaluate various engineering problems subjected to dynamic and thermal conditions for optimum solutions	K5

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
Formulation Techniques: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions	**[10]**
UNIT – II:	**[09]**
One-Dimensional Problems: Bar, trusses, beams and frames, displacements,	

stresses and temperature effects.

UNIT – III:

Two Dimensional Problems: CST, Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. **[09]**

UNIT – IV:

Iso-Parametric Formulation: Concepts, sub-parametric, super parametric elements, numerical integration, LST, four-nodded and eight-nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. **Convergence**: Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle, Patch test **[10]**

UNIT – V:

Dynamic Problems: Analysis, Eigen value problems, and their solution methods. **[10]**

Heat Transfer problems: Conduction and convection, examples: - One & two-dimensional fin. Introduction to non linear problems.

TEXTBOOKS:

1. Finite element methods by Chandrupatla&Belegundu.
2. Finite Element Analysis by P. Seshu, PHI learning private limited, New Delhi.

REFERENCE BOOKS:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press,1994
2. Zienckiwicz O.C. and R. L. Taylor, Finite Element Method, McGraw-Hill,1983
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996
4. Concepts and applications of finite element analysis, R.D.Cook et al. Wiley

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	ADVANCED CAD (*Program Core - 2*)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- Understand the fundamentals of CAD tools, software requirements, and geometric modeling techniques
- Explain and apply 2D and 3D geometric transformations, projections, and rendering techniques.
- Analyze various curve and surface modeling techniques used in engineering design.
- Develop and manipulate solid models using different modeling techniques such as B-Rep and CSG.
- Evaluate CAD software based on interoperability, data exchange formats, and dimensioning standards.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Define and describe the role and structure of CAD tools, graphics software, and standards.	K1 & K2
CO2	Apply 2D and 3D transformations, projections, and rendering techniques to model objects.	K3
CO3	Analyze parametric curve and surface representations used in CAD.	K4
CO4	Create complex solid models using Boolean operations, B-rep, and CSG methods.	K6
CO5	Evaluate CAD software based on file format support, modeling features, and standards.	K5

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
CAD Tools: Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient use of CAD software. Basics of Geometric Modeling: Requirement of geometric 3D Modeling, Geometric models, Geometric construction methods, Modeling facilities desired	**[09]**
UNIT – II:	
Transformations: 2-D and 3-D transformations: translation, scaling, rotation, reflection, concatenation, homogeneous coordinates, Perspective projection,	**[10]**

orthotropic projection, isometric projection, Hidden surface removal, shading, rendering. Evaluation Criteria: Evaluation criteria of CAD software, Data exchange formats: GKS, IGES, PHIGS, CGM, STEP Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC), Regardless of feature size (RFS).

UNIT – III:

Geometric Modeling: Classification of wireframe entities, Curve representation methods, Parametric representation of analytic curves: line, circle, arc, conics, Parametric representation of synthetic curves: Hermite cubic curve, Bezier curve, B-Spline curve wire, NURBS, Curve manipulations. **[10]**

UNIT – IV:

Surface Modeling: Classification of surface entities, Surface representation methods, Parametric representation of analytic surfaces: plane surface, ruled surface, surface of revolution, tabulated cylinder, Parametric representation of synthetic curves: Hermite cubic surface, Bezier surface, B-Spline surface, Blending surface, Surface manipulations. **[12]**

UNIT – V:

Solid Modeling: Geometry and topology, Boundary representation, The Euler-Poincare formula, Euler operators, Constructive solid geometry: CSG primitives, Boolean operators, CSG expressions, Interior, Exterior, closure, Sweeping: linear and non-linear, Solid manipulations, feature modeling. **[09]**

TEXTBOOKS:

1. CAD/CAM Concepts and Applications/ Alavala/ PHI.
2. Mastering CAD/CAM / IbrhimZeid / McGraw Hill International.
3. CAD/CAM Principles and Applications/ P.N. Rao/TMH/3rd Edition

REFERENCE BOOKS:

1. CAD/CAM /Groover M.P./ Pearson education
2. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age
3. Principles of Computer Aided Design and Manufacturing/ FaridAmirouche/ Pearson
4. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

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<table>
<tr><td rowspan="2">I Semester</td><td rowspan="2">AI & ML FOR MECHANICAL ENGINEERING
(Program Core - 3)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
</table>

COURSE OBJECTIVES:

- To impart the basic concepts of artificial intelligence and the principles of knowledge representation and reasoning.
- To introduce the machine learning concepts and supervised learning methods
- To enable the students gain knowledge in unsupervised learning method and Bayesian algorithms.
- To make the students learn about neural networks and genetic algorithms.
- To understand the machine learning analytics and applications of deep learning techniques to mechanical engineering.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Explain the basic concepts of artificial intelligence	K2
CO2	Learn about the principles of supervised learning methods	K2
CO3	Gain knowledge in unsupervised learning method and Bayesian algorithms	K2 & K4
CO4	Get knowledge about neural networks and genetic algorithms.	K2 & K4
CO5	Understand the machine learning analytics and apply deep learning techniques to mechanical engineering applications.	K2, K4 & K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*

UNIT – I:

Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and Environments; Good Behaviour - concept of rationality, the nature of environments, structure of agents.

Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real-world, regression and classification problems, performance metrics, differences between supervised and unsupervised learning paradigms, bias, variance, overfitting and under fitting.

Supervised Learning: Linear regression, logistic regression, Distance-based methods, Nearest-Neighbours, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods.

UNIT – II:

Unsupervised Learning: Clustering**,** K-means, Dimensionality Reduction, PCA and Kernel.

Bayesian and Computational Learning: Bayes theorem, concept learning, maximum likelihood of normal, binomial, exponential, and Poisson distributions, minimum description length principle, Naïve Bayes Classifier, Instance-based Learning- K-Nearest neighbour learning.

UNIT – III:

Neural Networks and Genetic Algorithms: Neural network representation, problems, perceptron, multilayer networks and backpropagation, steepest descent method, Convolutional neural networks and their applications,Local vs Global optima, Introduction to Genetic algorithms.

UNIT – IV:

Deep Learning: Recurrent Neural Networks and their applications, LSTM,Deep generative models, Deep auto-encoders, Applications of Deep Networks.

Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods - Boosting, Bagging, and Random Forests.

UNIT – V:

Overview of Applications to Mechanical Engineering: Introduction to Machine learning packages, preparation of dataset for machine learning (cleansing and featuring)

Design of1D mechanical structures,Crack detection, fatigue life and creep estimation, Defect detection in casting and welding, Tool wear and Surface roughness prediction in CNC machining, Heat exchanger design optimization, fault classification.

TEXTBOOKS:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
2. Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
3. EthemAlpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.

REFERENCE BOOKS:

1. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
2. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.

WEB REFERENCES:

- https://www.tpointtech.com/artificial-intelligence-ai
- https://www.geeksforgeeks.org/

I Semester	MECHANICAL BEHAVIOR OF MATERIALS & CHARACTRIZATION (*Program Elective – I*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To teach students the mechanical properties and behaviour of materials.
- To develop the student's ability to understand and apply the various theories of stress and strain in three dimensions along with the applications.
- To train students to identify, formulate, and solve engineering problems involving resistance to plastic deformation, fatigue, and fracture.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Describe effects of elasticity and plastic deformation on mechanical properties of engineering materials subjected to various static and dynamic loadings.	K2
CO2	Apply the Griffith's theory to different materials to analyse the fracture toughness and stress intensity factor on their performance.	K3
CO3	Analyse the effect of various metallurgical properties on the engineering materials subjected to fatigue and creep.	K4
CO4	Identify modern metallic materials for the various engineering applications.	K3
CO5	Describe the properties, processing and applications of polymer–matrix and ceramic–matrix composites.	K2

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
Elasticity in metals, mechanism of plastic deformation, slip and twinning, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behaviour, super plasticity, Yield criteria: Von-mises and Tresca criteria.	**[10]**
	[08]

UNIT – II:

Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.

UNIT – III:

Fatigue, fatigue limit, features of fatigue fracture, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and Paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis. Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep. **[10]**

UNIT – IV:

Optical Microscopy, XRD, SEM, TEM: Introduction, principles, Instrumentation, Specimen preparation-metallographic principles, Imaging Modes, Applications and Limitations. **[10]**

UNIT – V:

Energy Dispersive Spectroscopy: Instrumentation, working procedure, Applications and Limitations.

Thermal Analysis: Instrumentation, experimental parameters, Differential thermal analysis, Differential Scanning Calorimetry, Basic principles, Instrumentation, working principles, Applications and Limitations. **[10]**

TEXTBOOKS:

1. Mechanical Behaviour of Materials/Thomas H. Courtney/ McGraw Hill/2nd Edition/2000.
2. Mechanical Metallurgy/George E. Dieter/McGraw Hill, 1998.
3. Material Science and Engineering/William D Callister/John Wiley and Sons.
4. Yang Leng: Materials Characterization-Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia) Pte Ltd., 2008.

REFERENCE BOOKS:

1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
2. Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson.
3. Material Science and Engineering/William D Callister/John Wiley and Sons.
4. Introduction to Ceramics, 2nd Edition by W. David Kingery, H. K. Bowen, Donald R. Uhlmann.
5. Robert F. Speyer: Thermal Analysis of Materials, Marcel Dekker Inc., New York, 1994.
6. V. T. Cherapin and A. K. Mallik: Experimental Techniques in Physical Metallurgy, Asia Publishing House, 1967 .
7. ASM Handbook: Materials Characterization, ASM International, 2008.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	OPTIMIZATION AND RELIABILITY (*Program Elective – I*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart the knowledge on Micro-manufacturing and Scaling Laws.
- To train the students to gain the skill in Mechanical micromachining, Advanced micromachining processes and associated computer/laboratory work.
- To create the awareness on Metrology, Micro-machine tool system, machining essentials including part registration and micro-manufacturing case studies.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.	K3 & K4
CO2	Apply numerous numerical methods to solve the engineering problems for optimization.	K3
CO3	Apply GA and GP optimization methods to solve the differential equations and analyse the differences between GA and GP.	K3 & K4
CO4	Apply optimization techniques to design and manufacturing systems for the optimization of process parameters.	K3
CO5	Understand and apply major concepts of reliability in engineering design for analysing the statistical experiments leading to reliability modeling.	K3 & K4

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1:	***Remember***	**K2:**	***Understand***	**K3:**	***Apply***
K4:	***Analyse***	**K5:**	***Evaluate***	**K6:**	***Create***

Unit Description	*Contact Hrs.*
UNIT – I: **Classical Optimization Techniques:** Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization technique.	**[10]**
UNIT – II: **Numerical Methods for Optimization:** Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods.	**[10]**

UNIT – III:

Genetic Algorithm (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP. **[12]**

Multi-Objective GA: Pareto's analysis, non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems.

UNIT – IV:

Applications of Optimization in Design and Manufacturing Systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence. **[09]**

UNIT – V:

Reliability: Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, and hazard analysis. **[07]**

TEXTBOOKS:

1. Optimization for Engineering Design – Kalyan Moy Deb, PHI Publishers.
2. Engineering Optimization – S. S. Rao, New Age Publishers.
3. Reliability Engineering by L. S. Srinath.
4. Multi objective genetic algorithm by Kalyan Moy Deb, PHI Publishers

REFERENCE BOOKS:

1. Genetic algorithms in Search, Optimization, and Machine learning – D. E. Goldberg, Addison-Wesley Publishers.
2. Multi objective Genetic algorithms - Kalyan Moy Deb, PHI Publishers.
3. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers.
4. An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009
5. Reliability Theory and Practice by I Bazovsky, Dover Publications, 2013

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	MECHATRONICS (*Program Elective – I*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart the basic knowledge and importance on Mechatronics in Engineering Fields among the students.
- To create the awareness on Mechatronics in Research and Application area.
- To impart the knowledge about the application and utility of Mechatronics used in various sectors and fields.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Identification and demonstration of key elements of mechatronics system and its representation in terms of block diagram.	K2
CO2	Describe the use of solid-state electronic devices, diodes, amplifiers, etc. in designing the mechatronics systems and MEMS.	K2
CO3	Illustrate the applications of various hydraulic, pneumatic, mechanical, electrical actuating systems and valves in designing the mechatronic systems.	K3
CO4	Develop the PLC ladder programming for the creation of real-time mechatronic system.	K6
CO5	Develop dynamic models using system interfacing and data acquisition methods to design mechatronics systems for future applications.	K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I: Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.	**[10]**
UNIT – II: Solid state electronic devices, P-N junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.	**[10]**
UNIT – III: Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and	**[12]**

pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems, Mechanical actuating systems and electrical actuating systems.

UNIT – IV:

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control. **[09]**

UNIT – V:

System and interfacing and data acquisition, DAQS, SCADA, Analogue to Digital and Digital to Analogue conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends. **[07]**

Modeling and analysis of mechatronics systems (case studies)

TEXTBOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK VijayaRaghavan/WILEY India Edition/2008.
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

REFERENCE BOOKS:

1. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
3. Mechatronics System Design / Devdasshetty / Richard / Thomson.
4. Mechatronics / M.D. Singh / J.G. Joshi/PHI.
5. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton.
6. Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	COMPUTATIONAL FLUID DYNAMICS (*Program Elective – I*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart the basic knowledge and importance on Mechatronics in Engineering Fields among the students.
- To create the awareness on Mechatronics in Research and Application area.
- To impart the knowledge about the application and utility of Mechatronics used in various sectors and fields.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Differentiate between different types of partial differential equations that govern fluid dynamics, such as conservation, continuity, momentum and energy equations.	K2
CO2	Understand and Implement Finite Difference methods for Elliptical, Parabolic and Hyperbolic form of Partial Differential Equations.	K2
CO3	DiscretizetheequationsusingFiniteVolumeMethodappliedtoDiffusionand Convective-Diffusion Equations and understand the solution methodology.	K3
CO4	DiscretizethegoverningequationsappliedtoSteadyandUnsteadyflowsusing Finite Volume Method.	K6
CO5	Develop the ability for FEM discretization for simple one dimensional steady and unsteady problems in fluid flow and heat transfer.	K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
A brief overview of the basic conservation equations for fluid flow and heat transfer, Boundary Conditions, classification of partial differential equations and pertinent physical behaviour, parabolic, elliptic and hyperbolic equations, role of characteristics. Over-View of Finite Element, Finite Difference and Finite Volume Methods. **Finite Difference Method:** Derivation of Finite Difference Equations, Accuracy of Finite Difference Equations. Numerical Errors: Round-off,	**[10]**

Truncation and Discretization Errors. Solution of discretized equations: Direct and Indirect or iterative methods, TDMA algorithm.
Elliptical Equations: Finite Difference Formulations, Iterative Solution Methods, Examples.
Parabolic Equations: Explicit Schemes and Von-Neumann Stability Analysis, Implicit Schemes, ADI Schemes, Approximate Factorization, Fractional Step Methods, Examples.

UNIT – II: [10]

Hyperbolic Equations: Explicit schemes and Von-Neumann stability analysis, Implicit schemes, multi-step methods, nonlinear problems, second order one-dimensional wave equations, Examples.
In-compressible Viscous Flows via FDM: Artificial Compressibility Method, Pressure Correction Methods and Vortex Methods, Examples.

UNIT – III: [12]

FINITE VOLUME METHOD -I: DIFFUSION PROBLEMS: Solutions for 1-D and 2-D steady-state diffusion problems.
CONVECTION-DIFFUSION PROBLEMS: Solutions using Central Differencing Scheme, Upward differencing scheme, Hybrid differencing Scheme, Power Law scheme, Higher order differencing schemes, TVD schemes.

UNIT – IV: [09]

FINITE VOLUME METHOD-II: STEADY FLOWS: Staggered grid, SIMPLE, SIMPLER, SIMPLEC and PISO algorithms.
UNSTEADY FLOWS: Solutions for Transient 1-D and 2-D Heat Conduction, Transient convection-diffusion problems, QUICK Scheme, Solutions using Transient SIMPLE and Transient PISO algorithms

UNIT – V: [07]

FINITE ELEMENT METHOD: Introduction. Weighted residual and variational formulations. Interpolation in one-dimensional case. Application of FEM to ID steady and unsteady problems in fluid flow and heat transfer

TEXTBOOKS:

1. Chung, T. J., 2010, Computational Fluid Dynamics, 2nd ed., Cambridge University Press.
2. Versteeg, H.K.,and Malalasekera,W.,2007, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd ed., Pearson Education Limited.
3. Gartling, D., and Reddy, J.N., 2010, The Finite Element Method in Heat Transfer and Fluid Dynamics, CRC Press.

REFERENCE BOOKS:

1. Patankar, S. V., 2017, Numerical Heat Transfer and Fluid Flow, Special Indian ed.,CRC Press.
2. Muralidhar K., and Sundararajan T. (Editors), 2017, Computational Fluid Flow andHeat Transfer, 2nd ed. tenth reprint, Narosa.
3. AndersonJr.,J.D.,2017,ComputationalFluidDynamics:TheBasicswithApplications, Indian ed., McGraw Hill Education.
4. Donea,J.,andHuerta,A.,2003,FiniteElementMethodsforFlowProblems,John Wiley & Sons, Ltd.
5. Zienkiewicz,O.C,Nithiarasu,P.,andTaylor,R.L,2013,TheFiniteElementMethod for Fluid Dynamics, 7th ed., Butterworth-Heinemann Ltd.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

R25 M.TECH CAD CAM COURSE STRUCTURE AND SYLLABUS

I Semester	MEMS: DESIGN AND MANUFACTURING (*Program Elective – II*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques.
- To design, analysis, fabrication and testing the MEMS based components.
- To find various opportunities in the emerging field of MEMS. about the application and utility of Mechatronics used in various sectors and fields.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Synthesize and characterize nanomaterials for engineering applications	K3 & K4
CO2	Design and analyze methods and tools for micro and nano manufacturing.	K2& K3
CO3	Improve the quality of MEMS by analyzing the variables of the underlying micro and nano manufacturing method.	K2
CO4	Apply the concepts of thermo fluid engineering.	K2 &K3
CO5	Select appropriate industrially-viable process, equipment and tools for a specific product.	K2

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
Overview and working principles of MEMS and Microsystems: MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & miniaturization, Applications of MEMs in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics	**[10]**
UNIT – II:	
Engineering Science for Microsystems Design and Fabrication: Atomic structure of Matter, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics.	**[10]**
UNIT – III:	
Engineering Mechanics for Microsystems Design: Static Bending of Thin plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin-	**[12]**

Film Mechanics, Overview of Finite Element Stress Analysis.

UNIT – IV:

Design Considerations, Process Design Mechanical Design, Mechanical design using FEM, Design of a Silicon Die for a Micro pressure sensor.

[09]

Materials for MEMS: Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers and Applications

UNIT – V:

Microsystems and their fabrication: Introduction to Micro systems Photolithography, Ion implantation, Diffusion and oxidation, Chemical and Physical vapor deposition, etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process and Applications. **[07]**

TEXTBOOKS:

1. Tia-Ran Hsu, MEMS & Microsystems. Design & Manufacturing, TMH 2002
2. Foundation of MEMS/ Chang Liu/Pearson, 2012

REFERENCE BOOKS:

1. An Introduction to Micro electro mechanical Systems Engineering by Maluf M., Artech House, Boston 2000
2. Micro robots and Micromechanical Systems by Trimmer, W.S.N., Sensors & Actuators, Vol 19, 1989.
3. Applied Partial Differential Equations by Trim, D.W., PWS-Kent Publishing, Boston, 1990.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

R25 M.TECH CAD CAM COURSE STRUCTURE AND SYLLABUS

I Semester	DESIGN FOR MANUFACTURING AND ASSEMBLY (*Program Elective – II*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify the manufacturing constraints that influences the design of parts and part systems.
- To introduce the Design for Manufacturability (DFM) methodology.
- To understand infeasible or impractical designs.
- To know automatic assembly transfer system.
- To understand design of manual assembly.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Explain the basic concepts of DFMA & their applications. Apply design rules to manual assembly.	K2
CO2	Apply design rules for ease of machining and understand the design recommendations for machined parts	K3
CO3	Enlist the selection, simulation, and design rules of casting processes. Also, to explain the design considerations for extruded sections and various forming processes.	K2
CO4	Explain the design considerations and effect of thermal stresses in welded joints and the design factors for forging.	K2
CO5	Describe the design considerations for automatic assembly and do quantitative analysis of assembly systems.	K1

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I: Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA during Product Design, Typical DFMA Case Studies, Overall Impact of DFMA on Industry. Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on	**[10]**

Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

UNIT – II:

Machining processes: Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts. **[10]**

UNIT – III:

Metal casting: Appraisal of various casting processes, selection of casting process, general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting. Extrusion & Sheet metal work: Design guidelines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking **[10]**

UNIT – IV:

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations. **[10]**

UNIT – V:

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines. **[09]**

TEXTBOOKS:

1. Product Design for Manufacture and Assembly, Geoffrey Boothroyd , Peter Dewhurst, Winston A. Knight, CRC Press, Third Edition,2010.
2. Design for Manufacturability Handbook, James G. Bralla, The McGraw-Hill Companies, Inc. 2nd edition, 1999.
3. Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.
4. Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000.
5. Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel and Dekken, N.Y. 1990.

REFERENCE BOOKS:

1. ASM Hand book, ASM International, 1997.
2. A Text Book of PRODUCTION TECHNOLOGY (Manufacturing Processes), P. C. Sharma, S. Chand Publishing, 2007.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	FRACTURE MECHANICS (*Program Elective – II*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Provide an understanding of the mechanics and micro-mechanisms of elastic and plastic deformation, creep, fracture, and fatigue failure, as applied to metals, ceramics, composites, thin film and biological materials.
- Provide a thorough introduction to the principles of fracture mechanics.
- Provide practical examples of the application of fracture mechanics to design and life prediction methods and reporting.
- Provide a basis for the use of fractography as a diagnostic tool for structural failures.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Ability to use simple continuum mechanics and elasticity to determine the stresses, strains, and displacements in a loaded structure.	K1
CO2	Understanding and mathematical modeling of the elements of plastic deformation, with respect to continuum and microscopic mechanisms.	K2 & K3
CO3	Ability to use creep data to predict the life of structures at elevated temperatures and the understanding of mechanisms of creep deformation and fracture.	K4 & K5
CO4	Use of fracture mechanics to quantitatively estimate failure criteria for both elastically and plastically deforming structures, in the design of life prediction strategies, and for fracture control plans, with examples from automotive, aerospace, medical, and other industries. Understanding of fatigue and how this affects structural lifetimes of components.	K4 & K5
CO5	Design of metals, ceramics, composites, and biological materials for optimal failure and fatigue analysis.	K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
Introduction: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, The ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature. **Griffiths analysis:** Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves.	**[10]**
UNIT – II:	
Linear Elastic Fracture Mechanics, (LEFM). Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor. The effect of Constraint, definition of plane stress and plane strain and the effect of component thickness. The plasticity at the crack tip and the principles behind the approximate derivation of plastic zone shape and size. Limits on the applicability of LEFM.	**[10]**
UNIT – III:	
Elastic-Plastic Fracture Mechanics; (EPFM). The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use. The effect of Microstructure on fracture mechanism and path, cleavage and ductile failure, factors improving toughness.	**[12]**
UNIT – IV:	
Fatigue: Definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodmans rule and Miners rule. Micromechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction	**[09]**
UNIT – V:	
Creep deformation: the evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep power law dependence. Comparison of creep performance under different conditions	**[07]**

extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

TEXTBOOKS:

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.
3. JE. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)

REFERENCE BOOKS:

1. JF. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
2. H.L.Ewald and R.J. Wanhill Fracture Mechanics, Edward Arnold, (1984).
3. S. Suresh, Fatigue of Materials, Cambridge University Press, (1998) L.B. Freund and S. Suresh Thin Film Materials Cambridge University Press, (2003).
4. G. E. Dieter, Mer hanical Metallurgy, McGraw Hill, (1988) 9. D.C. Stouffer and T. Dame, Inelastic Deformation of Metals, Wiley (1996)
5. F.R.N. Nabarro, ILL. de Villiers, The Physics of Creep, Taylor and Francis, (1995)

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

R25 M.TECH CAD CAM COURSE STRUCTURE AND SYLLABUS

I Semester	SMART MATERIALS (*Program Elective – II*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Knowing the behavior of Piezoelectric and magnetostrictive materials and their suitability as sensors in smart structures.
- Understanding the behavior of IPMC, Shape memory alloys and Rhelogical fluids and applied as Biometric sensors, as actuators in medical devices, aerospace and automotive industry, and as insulating membrane in bearings respectively.
- Studying about different sensors and their role in health monitoring systems.
- Develop different actuators for vibration control.
- Designing the smart systems using self sensing and self healing systems.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Knowing the behavior of Piezoelectric and magnetostrictive materials and their suitability as sensors in smart structures.	K2
CO2	Understanding the behavior of IPMC, Shape memory alloys and Rhelogical fluids and applied as Biometric sensors, as actuators in medical devices, aerospace and automotive industry, and as insulating membrane in bearings respectively.	K2
CO3	Studying about different sensors and their role in health monitoring systems.	K2 & K4
CO4	Develop different actuators for vibration control.	K3 & K6
CO5	Designing the smart systems using self sensing and self healing systems	K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I: **Introduction:** Introduction to Smart Materials, Principles of Piezoelectricty, Perovskyte Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect.	**[10]**
UNIT – II: Introduction to Electro-active Materials, Electronic Materials, Electro-active	**[10]**

Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rhelological Fluids.

UNIT – III:

Piezoelctric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors. **[12]**

UNIT – IV:

Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magnetovolume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control. **[09]**

UNIT – V:

Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design. **[07]**

TEXTBOOKS:

1. Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2. Functional and Smart materials by Z L Wang and Z C Kang, Plenium Press
3. Gauenzi, P., Smart Structures, Wiley, 2009

REFERENCE BOOKS:

1. Cady, W. G., Piezoelectricity, Dover Publication
2. Smart materials: Integrated design, Engineering approaches and potential applications,
3. AncaFilimon, Apple Academic Press

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	MATERIAL PROCESSING & CHARACTERIZAION LAB	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To impart the knowledge of metal joining and forming process.
- To familiarise the various advanced manufacturing processes to develop bulk materials.
- To train the students to make them expertise in operating material characterisation testing equipment to interpret the results for further analysis.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Apply the different manufacturing operations such as joining and forming processes to develop simple additive components.	K3
CO2	Apply the subtractive manufacturing processes to the bulk materials to study the effects of process parameters on morphological and mechanical properties of the materials.	K3&K4
CO3	Apply the solid-state additive methods to study the effects of operational parameters on the morphology and density of the materials.	K3& K4
CO4	Develop the additively manufactured components to investigate the mechanical properties of the various engineering materials.	K2 & K3
CO5	Analyse the effects of process parameters of EDM technique to investigate the surface integrity of the test specimen using different characterization methods like XRD, POD, spectroscopic methods – UV-Vis, FTIR, Raman, microscopic – optical, SEM etc.	K3 & K4

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

UNIT WISE SYLLABUS AND CONTACT HOURS (Total: 48):

Unit Description	*Contact Hrs.*
Perform the following experiments during the laboratory duration:	**[48]**

(Any 12 experiments from the following)

1] To prepare the cup/ hole shape from the given work piece using deep drawing press.
2] Study of cutting ratio/chip thickness ratio in orthogonal cutting with different materials.
3] Determination of cutting Forces and roughness on machined surface in orthogonal cutting with different materials.
4] Study of arc, and spot-welding processes.
5] Study of TIG, MIG welding and Friction stir welding processes.
6] Study of sintered density and relative density of given samples using Archimedes principle.
7] Study and preparation of simple parts in 3D printing.
8] Study of MRR and roughness on Wire EDM.
9] Estimation of particle size using top-down approaches and image analyzer.
10] To find the ultimate tensile strength of given specimen using UTM.
11] To find the Vickers/ Rockwell hardness of given specimen using hardness tester
12] To find the wear rate of a given specimen using Pin-on Disc apparatus
13] Study of roughness on machines surfaces for different materials using abrasive flow finishing.
14] To find the fatigue strength of a given specimen using fatigue-testing machine.
15] To find the crystallite size and miller indices planes of a given specimen using X-ray diffractometer.
16] Study of Raman/FTIR spectroscopy

I Semester	ADVANCED CAE LAB	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To achieve a fundamental understanding of software for modelling and analysing.
- To comprehend the various types of analysis and use the fundamental ideas to determine the stress and other relevant characteristics of bars and beams loaded under loading circumstances.
- Learn how to implement fundamental concepts to perform dynamic and thermal analysis to determine the natural frequencies and temperature distribution throughout the processes.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Formulate problems, generate geometry, discretize problems, apply boundary conditions, and solve problems of bars, trusses, beams, and plates to determine stress under different loading scenarios by using the fundamental knowledge of an analysis package and contemporary tools.	K4
CO2	Create shear force and bending moment diagrams, further apply and analyse the deflection of beams under point, uniformly distributed, and varying loads.	K6
CO3	Perform dynamic analysis to evaluate the natural frequencies for different boundary conditions and force function analysis.	K5
CO4	Apply the fundamental principles to analyse and interpret the results for 1D, 2D, and 3D problems subjected to heat transfer with conduction and convection boundary conditions.	K3

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

UNIT WISE SYLLABUS AND CONTACT HOURS (Total: 48):

Unit Description	*Contact Hrs.*
STRUCTURAL ANALYSIS:	**[10]**

1] Static Analysis
2] Modal Analysis
3] Harmonic Analysis
4] Spectrum Analysis
5] Buckling Analysis
6] Analysis of Composites
7] Fracture mechanics.

THERMAL ANALYSIS: **[05]**

1] Steady state thermal analysis
2] Transient thermal analysis

TRANSIENT ANALYSIS: **[05]**

Using any FEA Package for different structures that can be discretised with 1D, 2D & 3D elements discrete.

I Semester	SEMINAR - 1	L	T	P	C
		0	0	0	2

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

R25 M.TECH CAD CAM COURSE STRUCTURE AND SYLLABUS

II Semester	ROBOTICS AND UAV SYSTEMS (*Program Core – I*)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To introduce Robotics and Automation including robot classification, design and selection, analysis and applications in industry.
- To provide information on various types of end effectors, their design, interfacing and selection.
- To provide the details of operations for a variety of sensory devices that are used on robot , the meaning of sensing, classification of sensor, that measure position, velocity & acceleration of robot joint.
- To familiarize the basic concepts of transformations performed by robot, to perform kinematics to and to gain knowledge on programming of robots.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Figure out, demonstrate the terminologies related to robotics technology, hardware components and apply logic for selection of robotic sub systems and systems.	K2 &K3
CO2	Apply the spatial transformations to evaluate forward Kinematics, inverse kinematics and Jacobian for serial and parallel robots.	K3& K5
CO3	Demonstrate knowledge of end effectors, design considerations and the interpretation of data from data acquisition systems.	K2
CO4	Apply the fundamental knowledge of robot programming methods to write small programs for desired application.	K3
CO5	Apply and design robot cell layouts and analyse their applications in various fields.	K3 & K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I: **Introduction**: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation scheme, work volume, robot drive systems, control systems and dynamic performance, precision of movement. **Control System and Components:** basic concepts and motion controllers, control system analysis, robot actuation and feedback components. **Sensors:** Desirable features, tactile, proximity and range sensors, uses sensors	**[10]**

in robotics. Positions sensors, velocity sensors, actuators, power transmission systems

UNIT – II:

Motion Analysis and Control: Manipulator kinematics, position representation, forward and inverse transformations, homogeneous transformations, manipulator path control, robot arm dynamics, configuration of a robot controller. Robot joint control design. **[10]**

UNIT – III:

End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.

Machine Vision: Functions, Sensing and Digitizing-imaging devices, Lighting techniques, Analog to digital single conversion, image storage: Image processing and Analysis-image data reduction, Segmentation, feature extraction, Object recognition. Training the vision system, Robotic application. **[12]**

UNIT – IV:

Robot Programming: Lead through programming, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching, capabilities and Limitations of lead through methods. **[09]**

Robot Languages: Textual robot Languages, Generations of robot programming languages, Robot language structures, Elements and function.

UNIT – V:

Robot Cell Design and Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Interlocks, Error detection, Work cell controller. **[07]**

Robot Applications: Material transfer, Machine loading/unloading, Processing operation, Assembly and Inspection, Future Application.

Introduction to Drone Technologies and It’s Applications.

TEXTBOOKS:

1. Industrial Robotics / Groover M P /Pearson Edu.
2. Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.

REFERENCE BOOKS:

1. Robotics / Fu K S/ McGraw Hill.
2. Robotic Engineering / Richard D. Klafter, Prentice Hall.
3. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.
4. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley
5. Introduction to Robotics by SK Saha, TheMcGrah Hill Company, 6th, 2012.
6. Robotics and Control / Mittal R K &Nagrath I J / TMH.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

II Semester	ADVANCED MANUFACTURING PROCESSES (*Program Core – 2*)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To make acquainted the various unconventional manufacturing processes.
- To know about the applications of advanced manufacturing processes (which are exceptional).
- To encourage the students for developing the models of Advanced Manufacturing Processes.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Describe the various non-traditional machining processes and analyse their performance characteristics.	K3 &K4
CO2	Explain the working principles of additive manufacturing methods and their applications in the field of manufacturing.	K2
CO3	Describe the different surface treatment processes, processing of ceramics and their applications.	K2
CO4	Demonstrate and apply different method for processing of composites and nanomaterials to analyse their characteristics subjected to the field of application.	K3 &K4
CO5	Describe different micro fabrication methods of microelectronic devices	K2

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description *Contact Hrs.*

UNIT – I:

Advanced Machining Processes: Introduction, Need, AJM, WJM, Wire-EDM, ECM & Ultrasonic Machining– Principle, working, advantages, limitations, Process Parameters & capabilities and applications. **[10]**

UNIT – II:

LBM, EBM, PAM – Principle, working, advantages, limitations, Process Parameters & capabilities and applications. **[10]**

Introduction to Additive Manufacturing: Working Principles, Methods, Stereo Lithography, LENS, LOM, Laser Sintering, Fused Deposition Method, 3DP Applications and Limitations.

UNIT – III:

Surface Treatment: Scope, Cleaners, Methods of cleaning, Surface coating types, Electro forming, Chemical vapour deposition, Physical vapour deposition, thermal spraying methods, Ion implantation, diffusion coating, ceramic and organic methods of coating, and cladding methods. **[12]**

Processing of Ceramics: Applications, characteristics, classification Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.

UNIT – IV:

Robot Programming: Lead through programming, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching, **Processing of Composites:** Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, processing methods for MMC, CMC, Polymer matrix composites. **[09]**

Processing of Nanomaterials: Introduction, Top-down Vs Bottom-up techniques-Ball milling, Lithography, Plasma Arc Discharge, Pulsed Laser Deposition, Sputtering, Sol-Gel, Molecular beam Epitaxy.

UNIT – V:

Fabrication of Microelectronic Devices: Crystal growth and wafer preparation, Film Deposition, oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, surface mount technology, Integrated circuit economics. **[07]**

TEXTBOOKS:

1. Manufacturing Engineering and Technology, Kalpakijian /Adisson Wesley, 1995.
2. Process and Materials of Manufacturing / R. A. Lindburg /11th edition, PHI 1990.

REFERENCE BOOKS:

1. Microelectronic packaging handbook/Rao. R. Thummala and Eugene, J. Rymaszewski/Van NostrandRenihold,
2. MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH.
3. Advanced Machining Processes / V.K.Jain / Allied Publications.
4. Introduction to Manufacturing Processes / John A ScheyIMcGraw Hill.
5. Introduction to Nanoscience and NanoTechnology/ Chattopadhyay K.K/A.N.Banerjee/ PHI.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

II Semester	COMPUTER AIDED MANUFACTURING (*Program Core – 3*)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- Understand the fundamentals, advantages, and applications of NC/CNC/DNC systems and CAD/CAM in manufacturing.
- Analyze and describe the construction and control features of CNC machine tools.
- Develop and apply CNC part programs for various manufacturing operations using manual and automated methods.
- Comprehend the concept, structure, and integration of Computer Integrated Manufacturing (CIM) systems.
- Understand and evaluate automatic identification and data capture technologies and their role in intelligent manufacturing.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Explain the basic concepts and applications of NC, CNC, and CAD/CAM in manufacturing.	K1 & K2
CO2	Describe the construction and working of CNC machine tool components and control systems.	K4
CO3	Write simple CNC part programs for basic machining operations like turning, milling, and drilling.	K3
CO4	Explain the concept, structure, and advantages of Computer Integrated Manufacturing (CIM).	K2
CO5	Identify and explain modern AIDC technologies like barcodes, RFID, and their role in manufacturing.	K2

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I: CNC Technology: An overview: Introduction, Classification, Advantage, Disadvantages and applications of NC/CNC/DNC and Machine Tool, product cycle and automation in CAD/CAM, Need of CAD/CAM, Computer Aided Process Planning (CAPP), Basic concepts of process planning.	**[10]**
UNIT – II: Design Of CNC: Constructional features of CNC machine tools, Design at ion of	**[10]**

axis in CNC systems, NC coordinate system, positional control, system devices; drives, ball screws, transducers, feedback devices.

UNIT – III:

Part Programming: CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc...), Special part programming, Advanced part programming, APT programming, macros, fixed cycles, CAM software **[12]**

UNIT – IV:

CIM: Introduction to CIM, Data flow in CIM, CIM wheel, Process involved in CIM, Need for CIM, Advantages & disadvantages of CIM, CIM integration, Challenges, Sub systems in CIM, Present Scenario, Future prospects; Production system: automation in production systems, Manual labour in production systems, Automation principles and strategies **[09]**

UNIT – V:

Automatic Identification and Data Capture: Introduction, Reasons for AIDC, bar code, RFID and other AIDC technologies, CAQC – Inspection metrology, CMM, Machine Vision, other optical inspection methods, Non optical Non-contact inspection technologies, Material handling and identification, computers in manufacturing industry – current scenario(AI, ML,DL, Digital manufacturing, IOT, Cloud based manufacturing). **[07]**

TEXTBOOKS:

1. Yoram Koren, “Computer Control of Manufacturing Systems”, Tata McGraw Hill Book Co..2005
2. Mikell P. Groover, “Automation, Production Systems, and Computer-Integrated Manufacturing”, Pearson Education; Fourth edition , 2016
3. P Radhakrishnan “CAD/CAM/CIM”, New Age International Pvt Ltd; Fourth edition, 2018

REFERENCE BOOKS:

1. John Stenerson, K e l l y Curran, Operation and Programming, PHI, New Delhi, 2009.
2. John Stenerson, KellyCurran, Operation and Programming, PHI, 2009.
3. TCChang, RAWysk and HPWang,Computer Aided Manufacturing PHI,New Delhi, 2009
4. Ibrahim Zeid and Sivasubramanian, R. CAD/CAM Theory and Practice, Tata McGraw Hill Publications, New Delhi, 2009.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

II Semester	PRECISION ENGINEERING (*Program Elective – III*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand accuracy and precision and learn how to test and improve machine tool alignment and part accuracy.
- Learn different precision manufacturing methods and surface finishing techniques.
- Understand various measurement tools and techniques used to check dimensions and surface quality.
- Learn the basics of nanotechnology and its applications in manufacturing tiny parts and materials.
- Understand how to use fits, tolerances, and geometric dimensioning to design and assemble parts correctly.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Evaluate the part and machine tool accuracies.	K5
CO2	Understand principles of ultra-precision machining, micro-manufacturing methods, and additive manufacturing	K2
CO3	Understand advanced metrology tools and techniques to measure and analyze components with high precision.	K2
CO4	Understand the principles and techniques of nanotechnology to develop and analyze nanoscale materials and devices for various applications	K2
CO5	Design and apply fits and tolerances using principles of dimensional chains for individual features for parts and assemblies according to ISO standards.	K3 & K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
Accuracy and Precision: Introduction - Accuracy and precision – Need – Application of precision machining- Alignment testing of machine tools, Accuracy of numerical control system, Accuracy specification of parts and assemblies.	**[10]**
	[10]

UNIT – II:

Precision Manufacturing: Micro machining processes-Diamond machining - Micro engraving - Micro replication techniques-Forming, Casting, Injection molding - Micro embossing. Methods of obtaining high quality surfaces, Lapping, Honing, Super finishing and Burnishing processes

UNIT – III:

Precision Metrology- In situ measurement- In process measurement of position of processing Point-Post process and online measurement of dimensional features- Mechanical measuring systems- Optical Measuring Systems- Optical Interferometry, Laser Scanning, White Light Interferometry Confocal Microscopy, Electron beam measuring Systems-Scanning Tunnelling-Atomic Force Microscope and XRay Computed Tomography. Surface Metrology- Surface Roughness and Measurement. **[12]**

UNIT – IV:

Quality assurance Nano precision technology: Fundamentals of nanotechnology, Nano physical processing of atomic-bitunits Nano chemical and electrochemical atomic-bit processing. –Nano-Grating systems –Nano lithography, Electron beam lithography –Mirror grinding of ceramics, Focused Ion Beam (FIB) Milling, Atomic Layer Deposition (ALD), Nano processing of materials for super high-density ICs-Nano-mechanical parts, Nano machines-NEMS, Applications- Nanoelectronics, Nanocomposites and nano coatings **[09]**

UNIT – V:

Geometric Dimensioning and Tolerancing: Tolerance and fits, Hole and shaft basis system, Types of fits- Types of assemblies-probability of clearance and interference fits in transitional fits, Concept of dimensional chain or tolerance stack. Dimensioning of stepped shaft and holes assigning tolerances on the constituent dimensions. Tolerance zone conversions-surfaces, Datum - Datum feature of representation-form controls, Logical approach to tolerancing-datum systems, Geometrical tolerances. **[07]**

TEXTBOOKS:

1. Precision Engineering in Manufacturing, R.L.Murty, New Age International Publishers, 1996.
2. V.K. Jain, Advanced Machining Processes, 12th reprint, Allied Publishers Ltd, 2010.
3. James, D. and Meadow, S., “Geometric Dimensioning and Tolerancing”, Marcel Dekker Inc.,1995.

REFERENCE BOOKS:

1. V.Kovan, "Fundamentals of Process Engineering", Foreign Languages Publishing House, Moscow, 1975
2. J.L.Gadjala, "Dimensional control in Precision Manufacturing", McGraw Hill Publishers.
3. Norio Tanigichi “Nano Technology”, oxford university press, 2003.
4. Venkatesh, V.C. and Sudin, I., “Precision Engineering”, Tata McGraw Hill Co., NewDelhi, 2007.
5. Liangchi Zhang, “Precision Machining of Advanced Materials”, Trans Tech Publications Ltd., Switzerland, 1st Edition, 2001.
6. X. Jane Jiang, Paul J. Scott, “Advanced Metrology: Freeform Surfaces”, Academic Press Inc, April 2020.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

		L	T	P	C
II Semester	**THEORY OF ELASTICITY AND PLASTICITY** (***Program Elective – III***)	**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To impart knowledge of Principal stresses and strains to develop analytical skills of solving problems using plain stress and plain strain.
- To develop analytical skills for solving two-dimensional elasticity problems in rectangular and polar coordinates.
- To impart knowledge of engineering application of torsion and plasticity.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Demonstrate, apply and analyse the 2D plane stress and plane strain problems subjected to various boundary conditions.	K4
CO2	Generate and solve the governing equations for the 2D elasticity problems in rectangular and polar co-ordinate systems using various methods.	K3
CO3	Analyse the stress and strain in 3D elasticity problems by employing different general methods.	K4
CO4	Apply the theory of elasticity concepts to solve torsional problems of both circular and non-circular shafts.	K3
CO5	Demonstrate the plastic behaviour from stress-strain curves for different materials and describe different strain-hardening models.	K2

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
Introduction: Elasticity –Notation for forces and stresses – Components of stresses –components of strain –Hooke's law. **Plane Stress and Plane Strain Analysis:** Plane stress-plane strain – Differential equations of equilibrium–Boundary conditions– Compatibility equations–stress function–Boundary conditions.	**[10]**
UNIT – II:	
Two Dimensional Problems in Rectangular Coordinates: Solution by polynomials–Saint Venant's principle–Determination of displacements–bending of simple beams–Application of Fourier series for two dimensional problems – gravity loading.	**[10]**

Two Dimensional Problems in Polar Coordinates: General Equation in polar coordinates – stress distribution symmetrical about an axis –Pure bending of curved bars – strain components in polar coordinates – Displace ments for symmetrical stress distributions – simple symmetric and asymmetric problems – General solution of two dimensional problem in polar coordinates – Application of the general solution of two dimensional problem in polar coordinates – Application of the general solution in polar coordinates.

UNIT – III:

Analysis of Stress and Strain in Three Dimensions: Principle stress – ellipsoid and stress – director surface – Determination of principle stresses – Maximum shear stresses– Homogeneous deformation – principle axis of strain rotation. **[12]**

GENERAL THEOREMS: Balance laws –Differential equations of equilibrium– conditions of compatibility – Determination of displacement– Equations of equilibrium in terms of displacements–principle of superposition–Uniqueness of solution –the Reciprocal theorem.

UNIT – IV:

Torsion of Prismatic Bars: General solution of problems by displacement (St. Venant's warping function) & force (Prandtl's stress function) approaches – Membrane analogy – Torsion of circular and non-circular (elliptic and rectangular) sections – Torsion of thin rectangular section and hollow thin-walled section – Single and multi-celled sections. **[09]**

UNIT – V:

Theory of Plasticity: Stress-strain curve – Theories of strength and failure – Yield Criteria – Yield Surface – Plastic Flow – Plastic Work – Plastic Potential – Strain hardening. **[07]**

TEXTBOOKS:

1. Timoshenko, S., Theory of Elasticity and Plasticity, MC Graw Hill Book company.
2. Sadhu Singh, Theory of Elasticity and Plasticity, Khanna Publishers.

REFERENCE BOOKS:

1. Popov, Advanced Strength of materials, MC Graw Hill Book Company.
2. Chen, W.F. and Han, D.J, Plasticity for structural Engineers, Springer-Verlag, New York.
3. Lubliner, J., Plasticity Theory, Mac Millan Publishing Co., New York.
4. Y.C.Fung., Foundations of Solid Mechanics, Prentice Hall India.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

II Semester	ENTREPRENUERSHIP & DESIGN OF BUSINESS MODELS (*Program Elective – III*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand what entrepreneurship is, the traits of successful entrepreneurs, and the skills needed.
- Learn about the business environment and the support systems available for entrepreneurs.
- Understand government policies and regulations affecting industries and international business.
- Learn how to prepare a business plan, including product selection, feasibility studies, and project evaluation.
- Understand how to start and manage a small business, including finance, marketing, and growth strategies.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Define entrepreneurship concepts, identify traits of successful entrepreneurs, and explain required skills.	K1 & K2
CO2	Describe the entrepreneurial environment and recognize support systems for new ventures.	K2
CO3	Explain industrial policies and regulations and their impact on business and international trade.	K2 & K4
CO4	Prepare basic business plans including product selection, feasibility study, and project evaluation.	K3 & K4
CO5	Plan and manage small business operations including finance, marketing, and growth strategies.	K3 & K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description — *Contact Hrs.*

UNIT – I:
ENTREPRENEURAL COMPETENCE :
Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur. **[10]**

UNIT – II:
ENTREPRENEURAL ENVIRONMENT: **[10]**
Business Environment - Role of Family and Society – Entrepreneurship

Development Training and Other Support Organisational Services.

UNIT – III:
INDUSTRIAL POLACIES :
Central and State Government Industrial Policies and Regulations - International Business. **[12]**

UNIT – IV:
BUSINESS PLAN PREPARATION :
Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria. **[09]**

UNIT – V: **[07]**

LAUNCHING OF SMALL BUSINESS:
Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups. Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

TEXTBOOKS:

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001.
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, NewDelhi, 2001.

REFERENCE BOOKS:

1. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms &Praxis, Biztrantra ,2nd Edition ,2005
2. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
3. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.
4. Arya Kumar. Entrepreneurship. Pearson. 2012 5. Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective. Cengage Learning. 2012

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

II Semester	ADDITIVE MANUFACTURING *(Program Elective – III)*	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide comprehensive knowledge of the wide range of additive manufacturing processes, capabilities and materials.
- To understand the software tools and techniques used for additive manufacturing.
- To create physical objects that facilitates product development/prototyping requirements

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Demonstrate a basic technical understanding of the physical principles, materials, and operation of the types of AM processes such as VAT Photo polymerization.	K2
CO2	Explain the working principles and analyse the process parameters of jetting and extrusion-based additive manufacturing processes.	K2& K4
CO3	Describe the laminated sheet based and powder based additive manufacturing processes and analyse the characteristic feature of the developed AM components.	K2 & K4
CO4	Identify appropriate sold-state additive manufacturing process for the desired application to generate metal AM components.	K3
CO5	Apply the key concepts of material science, and well-designed guidelines to analyse the effect of post processing operations of different AM processes.	K3 &K4

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description — *Contact Hrs.*

UNIT – I:

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM. **[10]**

VAT Photo polymerization AM Processes: Stereo lithography (SL), Materials, Process Modelling, SL resin curing process, SL scan patterns, Micro-stereo lithography, Mask Projection Processes, Two-Photon vat photo polymerization, Process Benefits and Drawbacks, Applications of Vat Photo polymerization, case studies.

UNIT – II:

Material Jetting AM Processes: Evolution of Printing as an Additive Manufacturing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Processes.

Binder Jetting AM Processes: Materials, Process Benefits and Drawbacks, Research achievements in printing deposition, technical challenges in printing, Applications of Binder Jetting Processes. **[10]**

Extrusion-Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, Bio-Extrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes, case studies.

UNIT – III:

Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated ObjectManufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOMand UC applications, case studies.

Powder Bed Fusion AM Processes: Selective laser Sintering(SLS),Materials, Powderfusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, **[12]**

Electron Beam melting (EBM): Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes, case studies.

UNIT – IV:

Directed Energy Deposition AM Processes: Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes.

Friction stir additive manufacturing: process, parameters, advantages, limitations and applications, Additive friction stir deposition process: principle, parameters, applications, functionally graded additive manufacturing components, Case studies. **[09]**

Wire Arc Additive Manufacturing: Process, parameters, applications, advantages and disadvantages, case studies.

UNIT – V:

Materials science for AM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, micro structural studies, Structure property relationship, case studies. **[07]**

Post Processing of AM Parts: Support Material Removal, Surface Texture

Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques, case studies.

Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.

TEXTBOOKS:

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.
2. 3D Printing and Additive Manufacturing: Principles & Applications, Chua CheeKai, Leong Kah Fai, World Scientific, 2015, 4th Edition.

REFERENCE BOOKS:

1. Rapid Prototyping: Laser-based and Other Technologies, Patri K. VenuVinod and Weiyin Ma, Springer, 2004.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
3. Rapid Prototyping: Principles and Applications in Manufacturing, RafiqNoorani, John Wiley & Sons, 2006.
4. Additive Manufacturing, Second Edition, Amit BandyopadhyaySusmita Bose, CRC Press Taylor & Francis Group, 2020.
5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A. N. Junoop, McGraw Hill, 2021.

WEB REFERENCES:

- Phttps://www.nist.gov/additive-manufacturing
- https://www.metal-am.com/
- http://additivemanufacturing.com/basics/
- https://www.3dprintingindustry.com/
- https://www.thingiverse.com/
- https://reprap.org/wiki/RepRap

II Semester	INTRODUCTION TO EMBEDDED SYSTEMS (*Program Elective – IV*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- This course emphasizes on comprehensive treatment of embedded hardware and real time operating systems along with case studies, in tune with the requirements of Industry.
- The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Acquire a basic knowledge about the fundamentals of embedded systems, characteristics and modelling challenges.	K2
CO2	Gain the knowledge about the hardware components of embedded systems and analyse their design and functionality.	K2 & K4
CO3	Describe the various communication devices, circuit emulators and buses used in embedded networking.	K2
CO4	Develop programming and system control to design an embedded systems for various applications	K2 & K3
CO5	Demonstrate and develop new real time operating system designs and models for embedded biomedical measuring systems	K2& K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I: **Fundamentals of Embedded System:** Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers),Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power – supply (Battery technology, Solar), PC Band Passive components, Safety and reliability, environmental issues. Ethical practice. Characteristics and quality attributes (Design Metric) of embedded system., Real time system's requirements, real time issues, interrupt latency. Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net,	**[10]**

UML.

UNIT – II:

Embedded Hardware and Design: IntroductiontoARM-v7-M (Cortex-M3),ARM-v7-R(CortexR4) and comparison in between them. **[10]**

UNIT – III:

Embedded Serial Communication: Study of basic communication protocols like SPI, SCI (RS232, RS485), I2C, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network. **[12]**

UNIT – IV:

Embedded Software, Firmware Concepts and Design: Embedded C-programming concepts (from embedded system point of view): Optimizing for Speed/Memory needs, Interrupt service routines, macros, functions, modifiers, data types, device drivers, Multi threading programming. (LaboratoryworkonJ2MEJava mobile application).

Basic embedded C programs/applications for ARM-v7, using ARM-GCC-tool-chain, Emulation of ARM-v7 (e.g., using QEMU), and Linux porting onARM-v7 (emulation) board. **[09]**

CASESTUDY: (a) Medical monitoring systems, (b) Process control system(temp, pressure), (c) Soft real time: Automated vending machines and (d) Communication: Wireless (sensor) networks.

UNIT – V:

Real time operating system: POSIX Compliance, Need of RTOS in Embedded system software, Foreground/Background systems, multi tasking, context switching, IPC, Scheduler policies, Architecture of kernel ,task scheduler, ISR, Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS. **[07]**

Introduction to µCOS - IIRTOS, study of kernel structure of µCOS-II, Synchronization in µCOS-II, Inter-task communication in µCOS-II, Memory management inµCOS-II, porting of RTOS on ARM-v7 (emulation) board, Application developments using µCOS-II.

Introduction Linux OS, Linux IPC usage, basic device (drivers) usage.

TEXTBOOKS:

1. Introduction to Embedded Systems :Shibu K. V. (TMH).
2. Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley).

REFERENCE BOOKS:

1. Embedded Systems : Rajkamal (TMH)
2. Embedded Systems : L. B. Das (Pearson)
3. Embedded System design : S. Heath (Elsevier)
4. Embedded microcontroller and processor design: G. Osborn (Pearson)
5. Embedded Systems: Frank Vahid , Wiley India, 2002

6. Embedded Microcomputer Systems – Real Time Interfacing – Jonathan W. Valvano; Cengage Learning; Third or later edition.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	MODELING AND SIMULATION OF MANUFACTURING SYSTEMS (*Program Elective – IV*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

Understand basic system concepts, types of systems, and the role of simulation in manufacturing.
Learn probability distributions and random number generation techniques used in simulation.
Study tests for random numbers, random variate generation, and validate simulation models.
Analyze simulation output data, explore simulation languages, and design simulation experiments.
Understand queueing models, Markov chains, and their applications in manufacturing systems.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Explain concepts of systems, modeling, and simulation applications in manufacturing.	K2
CO2	Identify and apply probability distributions and random number generation methods in simulations.	K2 & K3
CO3	Perform tests for randomness and validate simulation models.	K3 & K4
CO4	Analyze output data from simulations and develop models using simulation languages.	K3 & K4
CO5	Explain and apply queueing and Markov chain models for manufacturing systems analysis.	K2 & K3

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description *Contact Hrs.*

UNIT – I:

Introduction to System and simulation: Concept of system and elements of system, Discrete and continuous system, Models of system and Principles of modeling and simulation, Monte carlo simulation, Types of simulation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system. **[10]**

UNIT – II:

Review of statistics and probability: Types of discrete and continuous probability distributions such as Geometric, Poisson, Uniform, Normal, Exponential distributions with examples. Random numbers: Need for RNs, **[10]** Technique for Random number generation such as Mid product method, Mid square method, and Linear congruential method with examples.

UNIT – III:

Test for Random numbers: Uniformity - Chi square test or Kolmogorov Smirnov test, Independency- Auto correlation test. Random Variate generation: Technique for Random variate generation such as Inverse transforms technique or Rejection method Analysis of simulation data: Input data analysis, Verification and validation of simulation models. **[12]**

UNIT – IV:

Output data analysis. Simulation languages: History of simulation languages, Comparison and selection of simulation languages. Design and evaluation of simulation experiments: Development and analysis of simulation models using simulation language with different manufacturing systems. **[09]**

UNIT – V:

Queueing models: Introduction, M/M/1 and M/M/m Models with examples, Open Queueing and Closed queueing network with examples. Markov chain models and others: Discrete time markov chain with examples, Continues time markov chain with examples, stochastic process in manufacturing, Game theory. **[07]**

TEXTBOOKS:

1. J.Banks, J.S. Carson, B. L. Nelson and D.M. Nicol, Discrete Event System Simulation", PHI, New Delhi, 2009.
2. A.M. Law, W.D.Kelton, Simulation Modeling and Analysis, Tata McGraw Hill Ltd, New Delhi, 2008.
3. N. Viswanadham, Y. Narahari, Performance Modeling of Automated Manufacturing Systems", PHI, New Delhi, 2007.

REFERENCE BOOKS:

1. Law, A. M., & Kelton, W. D. (2000). Simulation, Modeling and Analysis (3rd ed.).
2. Pritsker, A. A. B. (1986). Introduction to Simulation and SLAM II (3rd ed.).
3. Smith, J. S. (2003). Survey on the use of simulation for manufacturing system design and operation. Journal of Manufacturing Systems, 22(1), 1-14.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	SMART MANUFACTURING (*Program Elective – IV*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- This course is introduced to impart the knowledge of smart manufacturing for industry 4.0 for making student innovative.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Employ the concept of Industry 4.0 for Smart Manufacturing and analyse the challenges more effectively in context of Industry 4.0.	K3 & K4
CO2	Recognize the requirement for different hardware and software, as well as the IoT Layers and their relative significance, in order to construct an Industry 4.0-compliant smart machine interface.	K2 & K4
CO3	Describe the Architecture of Cyber – Physical System (CPS) and apply to make the machines more oriented towards Industry 4.0 in enhancing the productivity.	K2 & K3
CO4	Describe the cloud-computing IoT platform for smart manufacturing and apply the AI & ML techniques in analysing the predictive maintenance of manufacturing systems.	K3& K4
CO5	Demonstrate the application of hardware, communication protocol, IOT platform, machine learning etc. to implement IoT for smart manufacturing for the need of Industry 4.0.	K2

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I: **Concepts of Smart Manufacturing:** Definition and key characteristics of smart manufacturing, corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing Six big losses in manufacturing with Industry 4.0, and their benefits.	**[10]**
UNIT – II: **Smart Machines and Smart Sensors:** Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors	**[10]**

in industry, Sensing for Manufacturing Process in IIoT, Block Diagram of aIIoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces.

UNIT – III:

Architecture of Cyber- Physical system (CPS): Functions of CPS, 5C Architecture; Smart Connection Level, Data-to- Information Level, Cyber Level, Cognition Level, Configuration Level. Design of PHM based CPS systems. Comparison of today's factory and Industry 4.0 factory by the implementation of 5C CPS architecture. **[12]**

UNIT – IV:

Digital Twin: Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology.

Predictive Maintenance: Introduction of predictive maintenance, difference between preventive and predictive maintenance, working and various components of predictive maintenance, benefits and tools of predictive maintenance. Common approaches to IoT predictive maintenance; Rule-based (condition monitoring) and AI (artificial intelligence) based predictive maintenance. **[09]**

Augmented Reality in Maintenance (Electrical & Mechanical).

UNIT – V:

IoT connectivity for Industry 4.0: Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity protocol. **[07]**

TEXTBOOKS:

1. Industry 4.0 The Industrial Internet of Things by Alasdair Gilchrist, Apress.
2. Industrial Internet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Houbing Song Danda B. Rawat, Springer.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

I Semester	INTRODUCTION TO QUANTUM TECHNOLOGIES (*Program Elective – IV*)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce fundamental concepts of quantum mechanics and its mathematical formalism.
- To explore quantum computing and communication principles and technologies.
- To understand the physical implementation and limitations of quantum systems.
- To enable students to relate quantum theory to practical applications in computing, cryptography, and sensing.
- To familiarize students with the emerging trends in quantum technologies.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Explain core principles of quantum mechanics and their technological implications.	K2
CO2	Analyze quantum phenomena like superposition and entanglement.	K4
CO3	Apply mathematical tools to model and solve quantum systems.	K3
CO4	Demonstrate understanding of quantum algorithms and quantum circuits.	K2 & K3
CO5	Evaluate potential applications and challenges in quantum communication and sensing.	K5

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description	*Contact Hrs.*
UNIT – I:	
Fundamentals of Quantum Mechanics: Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrodinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.	**[10]**
UNIT – II:	
Quantum Information Theory: Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational	**[10]**

basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory)

UNIT – III:

Quantum Computing: Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover's search algorithm, Oracle and amplitude amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip, phase-flip, Introduction to quantum programming: Qiskit(overview) **[12]**

UNIT – IV:

Quantum Communication: Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise) **[09]**

UNIT – V:

Quantum Technologies and Applications: Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era. **[07]**

TEXTBOOKS:

1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang
2. "Quantum Mechanics: Concepts and Applications" by Nouredine Zettili

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

DEPARTMENT OF MECHANICAL ENGINEERING

R25 M.TECH CAD CAM COURSE STRUCTURE AND SYLLABUS

I Semester	ROBOTICS AND UAV SYSTEMS LAB	L	T	P	C
		0	1	2	2

COURSE OBJECTIVES:

- To develop the student's knowledge in various robot structures and their workspace, skills in performing spatial transformations, analysis skills associated with trajectory planning and robot control.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Demonstrate the functional aspects of various subcomponents of robot in the workspace environment.	K2
CO2	Write and simulate trajectory planning in performing various operations like Pick and Place. Loading and unloading, etc.	K3

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

UNIT WISE SYLLABUS AND CONTACT HOURS (Total: 20):

Unit Description	*Contact Hrs.*
The following robot programming exercises are to be performed on a robot:	**[20]**

1. Operator control and jogging in the world coordinate system; Jogging in the tool coordinate system
2. Tool calibration – pen; Tool calibration – gripper, 2-point method
3. Jogging in the base coordinate system; Base calibration – table, 3-point method
4. Executing robot programs
5. CP motion and approximate positioning
6. Path contour with spline block
7. Motion programming with spline
8. Gripper programming – plastic panel and Pen
9. Jogging with a fixed tool; Calibrating an external tool and robot-guided work piece
10. Motion programming with external TCP
11. Programming a subprogram call
12. Use of loops, Constant velocity range and conditional stop and Automatic

External.

13. Demonstrate the use of a robot for automation of pick and place and arc and spot welding processes
14. Demonstrate automation of machining processes using a Flexible Manufacturing system

<u>The following exercises are to be performed on Drone technologies</u>:

1. Demonstration of parts and functions of a drone.
2. Demonstration of effects of forces, manoeuvres of a drone by roll, pitch and yaw.
3. Demonstration of various sensors and battery management used in drones.
4. Build a prototype drone to record videos and photos.

<u>Students need to refer to the following links:</u>

1. https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2. https://atl.aim.gov.in/ATL-Equipment-Manual/
3. https://aim.gov.in/pdf/Level-1.pdf
4. https://aim.gov.in/pdf/Level-2.pdf
5. https://aim.gov.in/pdf/Level-3.pdf
6. https://aim.gov.in/pdf/ATL_Drone_Module.pdf

II Semester	ADVANCED CAM LAB	L	T	P	C
		0	1	2	2

COURSE OBJECTIVES:

- To learn software like Z-Cast Pro, AFDEX and NX-11
- To apply basic concept to drawing and editing to develop 3D Modelling.
- To make 3D modelling, Assembling, modification & manipulation along with detailing.
- To learn and prepare the part programming for the simulation of various machining processes.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Simulate and analyse different Casting processes using a software packages- Z-Cast Pro	K3& K4
CO2	Simulate and analyse different Forging processes using a software package- AFDEX	K3& K4
CO3	Simulate and analyse different Forming processes using a software package- AFDEX	K3& K4
CO4	Write and simulate the manual part programming of lathe, drilling and milling operations using G&M codes- NX11	K2 & K3
CO5	Write and simulate the manual part programming drilling and milling operations using G&M codes- NX11	K2 & K3

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

UNIT WISE SYLLABUS AND CONTACT HOURS (Total: 48):

Unit Description	*Contact Hrs.*

CYCLE – I: **[24]**

Casting and Metal Forming processes:
Simulate and analyses the following processes using a software package.

1. Sand Casting
2. Die Casting
3. Cyclic Casting
4. Two stage Cold Forging

5. Multi-stage Cold Forging
6. Two stage Hot Forging
7. Trimming
8. Piercing
9. Drawing
10. Extrusion

CYCLE – II: **[24]**

CAM Packages:

1. To write and simulate the plain turning and facing part program for a given component.
2. To write and simulate the taper turning part program for a given component.
3. To write and simulate the step turning part program for a given component.
4. To write and simulate the circular interpolation part program for a given component.
5. To write and simulate the threading part program for a given component.
6. To write and simulate the face milling part program for a given component.
7. To write and simulate the contour milling part program for a given component.
8. To write and simulate the pocket drilling part program for a given component.

		L	T	P	C
II Semester	**SEMINAR - II**	**0**	**0**	**2**	**1**

III Semester	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the knowledge on basics of research and its types.
- To impart the concept of Literature Review, Technical Reading, Attributions and Citations.
- To know the Ethics in Engineering Research.
- To know the concepts of Intellectual Property Rights in Engineering.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	*BTL (K#)*
CO1	Explain the meaning of engineering research and apply to develop an appropriate framework for research studies.	K2& K3
CO2	Identify the procedure of Literature Review, Technical Reading, etc. and apply to develop a research design during their project work.	K2 & K3
CO3	Explain and apply the fundamentals of patent laws and drafting procedure in their research works.	K2& K3
CO4	Demonstrate the copyright laws, subject matters of copyrights, designs etc. to apply in patent filing.	K2 & K3
CO5	Identify the new developments in IPR and employ the applications of computer software in writing/filing patents in future.	K2 & K3

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

Unit Description *Contact Hrs.*

UNIT – I: **[10]**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT – II: **[10]**

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

[10]

UNIT – III:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – IV: **[10]**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT – V: **[09]**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR.

TEXTBOOKS:

1. C.R. Kothari , 2nd Edition, "Research Methodology: Methods and Techniques".
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step-by-Step Guide for beginners"

REFERENCE BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction".
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.,

III Semester	SUMMER INTERNSHIP	L	T	P	C
		0	0	0	3

COURSE OBJECTIVES:

- Internships provide students with an opportunity to put into practice skills they have learned while in college.
- In addition, students should have an opportunity to enhance those skills, obtain the perspective of a work environment and benefit from a mentor or supervisor's experience and advice.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Integrate theory and practice to assess interests and abilities in their field of study.	K3 & K4
CO2	Develop work habits, attitudes necessary to appreciate work and its function in the economy.	K3
CO3	Develop communication, interpersonal and other critical skills to build a record of work experience.	K3

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1:	***Remember***	**K2:**	***Understand***	**K3:**	***Apply***
K4:	***Analyse***	**K5:**	***Evaluate***	**K6:**	***Create***

III Semester	COMPREHENSIVE VIVA	L	T	P	C
		0	0	0	2

III Semester	DISSERTATION PART A	L	T	P	C
		0	0	20	10

COURSE OBJECTIVES:

- To impart fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study.
- To familiarise how to incorporate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.
- Expose to the critical aspects like identifying, analysing and solving problems creatively through sustained critical investigation using effective oral, written and visual communications.
- To inculcate the key aspects like awareness and application of appropriate personal, societal and professional ethical standards to excellence needed to engage in lifelong learning.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Carryout a critical review of literature on a chosen topic of research and identify gaps in the literature to define a problem for research work.	K3 & K4
CO2	Formulate/adapt a clear methodology using multi-disciplinary approach and modern tools.	K3& K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1: ***Remember***	**K2:** ***Understand***	**K3:** ***Apply***
K4: ***Analyse***	**K5:** ***Evaluate***	**K6:** ***Create***

IV Semester	DISSERTATION PART B (*Main Project*)	L	T	P	C
		0	0	32	16

COURSE OBJECTIVES:

- To impart fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study.
- To familiarise how to incorporate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.
- Expose to the critical aspects like identifying, analysing and solving problems creatively through sustained critical investigation using effective oral, written and visual communications.
- To inculcate the key aspects like awareness and application of appropriate personal, societal and professional ethical standardsto excellence needed to engage in lifelong learning.

COURSE OUTCOMES:
Upon successful completion of this course, the student will be able to:

	Course Outcome	***BTL (K#)***
CO1	Carryout design/analysis of a product/system or devise experiments to study and develop a system/process/product.	K3 & K4
CO2	Interpret & validate results of analysis/experiments conducted to study behaviour of a product /system/ process considered for the research leading to valid conclusions that add value to the body of knowledge.	K3 & K5
CO3	Write and present a technical report of the project work.	K6

 # Based on suggested Revised Blooms Taxonomy Level (BTL)

K1:	***Remember***	**K2:**	***Understand***	**K3:**	***Apply***
K4:	***Analyse***	**K5:**	***Evaluate***	**K6:**	***Create***