BONAM VENKATA CHALAMAYYA ENGINEERING COLLEGE

(An Autonomous Institution)

Department of Mechanical Engineering

M. TECH (BR25) ADVANCED MANUFACTURING SYSTEMS

COURSE STRUCTURE & SYLLABUS

Course Structure:

I - Semester

S.No	Course Code	Course Name	L	T	P	Credits
1	25AM1T01	Automation in Manufacturing	3	1	0	4
2	25AM1T02	Advanced Manufacturing Processes	3	1	0	4
3	25AM1T03	AI&ML for Mechanical Engineering	3	1	0	4
4		Program Elective – 1	3	0	0	3
	25AM1D01	Design for Manufacturing & Assembly				
	25AM1D02	Quality Engineering in Manufacturing				
	25AM1D03	Industrial Robotics				
	25AM1D04	Introduction to Quantum Technologies				
5		Program Elective – 2	3	0	0	3
	25AM1D05	Optimization & Reliability				
	25AM1D06	Nano Technology				
	25AM1D07	Precision Engineering				
	25AM1D08	Additive Manufacturing				
6	25AM1L01	Advanced CAD Lab	0	0	4	2
7	25AM1L02	Advanced Manufacturing Lab	0	0	4	2
8	25AM1S01	Seminar I	0	0	2	1
					Total	23

	online	online	online	online	
Dr. M. Kumara Swamy Assoc. Professor, Dept. of ME, UCEK (A), JNTUK	Dr. M. Ravi Sankar Prof. & Head, Dept. of ME, IITTP	Dr. T. Babu Rao, Asst. Professor, Dept. of ME, NITAP	Mr. K. M. Dakshina Murty, Sr. DGM, BHEL-HYD	Mr. U. Srinivas Technical officer C, ISRO-SHAR, Sriharikota	Dr. M. Naveen Srinivas, HOD-ME, BVCE(A)
Member-Affiliating Univ. Nominee	Subject Expert	Subject Expert	Industry Expert	PG Alumni	Chair-person BOS

***Course Structure*:**

II- Semester

S.No	Course Code	Course Name	L	T	P	Credits
1	25AM2T04	Advanced Finite Element Methods	3	1	0	4
2	25AM2T05	Computer Integrated Manufacturing	3	1	0	4
3	25AM2T06	Advanced CNC Technologies	3	1	0	4
4		Program Elective – 3	3		0	3
	25AM2D09	Smart Materials				
	25AM2D10	Production and Operation Management				
	25AM2D11	MEMS: Design and Manufacturing				
	25AM2D12	Total Quality Management				
5		Program Elective – 4	3		0	3
	25AM2D13	Mechatronics				
	25AM2D14	Theory of Plasticity				
	25AM2D15	Design and Analysis of Experiments				
	25AM2D16	Green Manufacturing				
6	25AM2L03	Material Characterization Lab	0	1	2	2
7	25AM2L04	Finite Element Simulation of Manufacturing Processes Lab	0	1	2	2
8	25AM2S02	Seminar II	0	0	2	1
					Total	23

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Course Structure:

III-Semester

S.No	Course Code	Course Name	L	T	P	Credits
1	25HM3D01	Research Methodology and IPR/Swayam 12 Week MOOC Course RM&IPR	3	0	0	3
2	25AM3P01	Summer Internship/Industrial Training (8-10 Weeks)	0	0	0	3
3	25AM3V01	Comprehensive Viva	0	0	0	2
4	25AM3P02	Dissertation Part - A	0	0	20	10
					Total	18

*MOOCS/NPTEL certification courses as per the approved list of internal BoS at the time of registration.

* Student Attended Summer/ Year Break and Assessment will be done in 3rd Sem

**Comprehensive viva can be conducted for the courses completed up to the Second Semester

*** Dissertation –Part A, Internal Assessment

Course Structure:

IV-Semester

IV SEMESTER						
S.No	Course Code	Course Name	L	T	P	Credits
1	25AM4P03	Dissertation Part - B	0	0	32	16
					Total	16

* External Assessment

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COURSE STRUCTURE & SYLLABUS

Year I Semester	AUTOMATION INMANUFACTURING (PROGRAMME CORE 1) (25AM1T01)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The objectives of this course are to:

1. Provide an overview of manufacturing systems and the role of automation in modern production environments.
2. Introduce hardware components and control systems used in automation, including PLCs and computer-based control.
3. Explain material handling systems, automated storage, and identification technologies like barcodes and RFID.
4. Describe manufacturing systems, assembly lines, automated production lines, and flexible manufacturing concepts.
5. Discuss quality control strategies, inspection techniques, and manufacturing support systems in automated environments.

COURSE OUTCOMES (COS)

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

CO No.	Course Outcome	Bloom's Level
CO1	Explain the structure and functions of production systems and the role of automation in manufacturing.	Understand
CO2	Identify and describe hardware components used in automation, including sensors, PLCs, and controllers.	Remember / Understand
CO3	Analyze and compare various material handling, storage, and identification technologies.	Analyze
CO4	Design and evaluate manufacturing and assembly systems including automated production lines and FMS.	Apply / Analyze
CO5	Assess quality control methods, inspection systems, and support tools used in automated manufacturing.	Evaluate

UNIT – I:

OVER VIEW OF MANUFACTURING AND AUTOMATION : Production systems, Automation in production systems, Automation principles and strategies, Manufacturing

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operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers.

UNIT – II:

MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES: Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

UNIT – III:

MANUFACTURING SYSTEMS AND AUTOMATED PRODUCTION LINES:
Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines.

UNIT – IV:

AUTOMATED ASSEMBLY SYSTEMS: Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis.

UNIT – V:

QUALITY CONTROL AND SUPPORT SYSTEMS: Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact Vs non contact, CMM. Manufacturing support systems. Quality function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.

TEXT BOOK:

1. Automation, production systems and computer integrated manufacturing/ Mikell.P Groover/PHI/3rd edition/2012,

REFERENCES:

1. CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahamanyarn and Raju/New Age International Publishers/2003.
2. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96.
3. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009
4. Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers

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I Year I Semester	ADVANCED MANUFACTURING PROCESSES (PROGRAMME CORE 2) (25AM1T02)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The course is designed to:

1. Provide knowledge on surface treatment techniques and advanced coating processes used in modern manufacturing.
2. Introduce processing methods for ceramics and composite materials, including powder metallurgy and finishing techniques.
3. Familiarize students with fabrication techniques used in the manufacture of microelectronic devices.
4. Explain the principles, working, and applications of advanced electrical and chemical machining processes.
5. Introduce laser, electron beam, abrasive jet, and water jet machining techniques and their role in precision manufacturing.

COURSE OUTCOMES (COS)

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

CO No.	Course Outcome	Bloom's Level
CO1	Explain various surface treatment and coating methods and evaluate their suitability for industrial applications.	Understand / Evaluate
CO2	Describe and compare processing techniques of ceramics and composites, including reinforcement strategies.	Understand / Analyze
CO3	Demonstrate understanding of microelectronic device fabrication processes, including lithography and packaging.	Understand / Apply
CO4	Analyze the principles, mechanisms, and applications of EDM, Wire EDM, and ECM processes.	Analyze
CO5	Evaluate non-traditional machining processes such as LBM, EBM, AJM, and WJM for advanced manufacturing applications.	Evaluate / Analyze

UNIT-I

SURFACE TREATMENT: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT- II

PROCESSING OF CERAMICS: Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, drying, sintering, hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT- III

FABRICATION OF MICROELECTRONIC DEVICES:

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics.

UNIT - IV

ADVANCED MACHINING PROCESSES: EDM, Wire EDM, ECM, LBM, EBM, AJM, WJM – Principle, working, limitations and applications.

UNIT -V

RAPID PROTOTYPING: Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing

TEXT BOOKS:

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

REFERENCES:

1. Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostrand Renihold,
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 Schey I Mc Graw Hill.

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I Year I Semester	AI & ML FOR MECHANICAL ENGINEERING (PROGRAMME CORE 3) (25AM1T03)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

CO1: Explain the basic concepts of artificial intelligence (K3).
CO2: Learn about the principles of supervised learning methods (K3)
CO3: Gain knowledge in unsupervised learning method and Bayesian algorithms (K2)
CO4: Get knowledge about neural networks and genetic algorithms (K2).
CO5: Understand the machine learning analytics and apply deep learning techniques to mechanical engineering applications (K2).

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.

TEXT BOOKS:

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.

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

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I Year I Semester	DESIGN FOR MANUFACTURING AND ASSEMBLY (PROGRAM ELECTIVE-1) (25AM1D01)	L	P	C
		3	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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).

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, and Effect of Part Symmetry, Thickness, and Weight on 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.

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 guide lines extruded sections-design principles for punching, blanking, bending, and deep drawing-Keeler Goodman forging line diagram – component design for blanking.

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.

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, and single station assembly lines.

TEXT BOOKS:

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

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I Year I Semester	QUALITY ENGINEERING IN MANUFACTURING (PROGRAM ELECTIVE-1) (25AM1D02)	L	T	P	C
		3	0	0	3

Course Objectives

The objectives of this course are to:

1. Introduce the concepts and importance of quality engineering in product and process design.
2. Explain the application of loss functions, tolerance design, and parameter design in improving quality and reducing variability.
3. Provide a foundation in statistical methods such as Analysis of Variance (ANOVA) for quality improvement.
4. Develop skills in designing and analyzing experiments using orthogonal arrays and Taguchi methods.
5. Familiarize students with Six Sigma methodology and tools for quality improvement in both manufacturing and service environments.

Course Outcomes (COs)

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

CO No.	Course Outcome	Bloom's Level
CO1	Explain the role of quality engineering in product and process design, including the use of loss functions.	Understand
CO2	Apply tolerance and parameter design concepts to improve quality in engineering designs.	Apply
CO3	Perform Analysis of Variance (ANOVA) for evaluating the effect of multiple factors on quality characteristics.	Apply / Analyze
CO4	Design and analyze experiments using orthogonal arrays to identify key process parameters and optimize performance.	Analyze / Evaluate
CO5	Implement Six Sigma DMAIC methodology and use statistical tools for process and quality improvement.	Apply / Evaluate

UNIT - I

QUALITY VALUE AND ENGINEERING: An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances (N-type, S- type and L-type)

UNIT II:

TOLERANCE DESIGN AND TOLERANCING: Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation fbr multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

UNIT – III

ANALYSIS OF VARIANCE (ANOVA): Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT - IV

ORTHOGONAL ARRAYS: Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

UNIT - V

SIX SIGMA AND THE TECHNICAL SYSTEM: Six sigma DMAIC methodology, tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.

TEXT BOOK:

1. Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995.

REFERENCES:

1. Quality Engineering in Production systems by G. Taguchi, A. Elsayed et al, McGraw Hill Intl. Pub 1989.
2. Taguchi Methods explained: Practical steps to Robust Design / Papan P. Bagchi / Prentice Hall Pvt. Ltd., New Delhi

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I Year I Semester	INDUSTRIAL ROBOTICS (Program Elective – I) (25AM1D03)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce Robotics and Automation including robot classification, design and selection, analysis and applications in industry.
2. To provide information on various types of end effectors, their design, interfacing and selection.
3. 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.
4. 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:

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).

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

UNIT – II:

	online	online	online	online	
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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.

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.

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. 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. Robot Applications: Material transfer, Machine loading/unloading, Processing operation, Assembly and Inspection, Future Application. Introduction to Drone Technologies and its 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.

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- Please include hyperlinks related to NPTEL/VLabs etc.

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I Year I Semester	INTRODUCTION TO QUANTUM TECHNOLOGIES (Program Elective – I) (25AM1D04)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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).

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, Eigen functions.

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 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)

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)

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.

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.

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I Year I Semester	OPTIMIZATION AND RELIABILITY (PROGRAM ELECTIVE-2) (25AM1D05)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To impart the knowledge on Micro-manufacturing and Scaling Laws.
2. To train the students to gain the skill in Mechanical micromachining, Advanced micromachining processes and associated computer/laboratory work.
3. 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:

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 (K3).

CO5 systems for the optimization of process parameters. Understand and apply major concepts of reliability in engineering design for analysing the statistical experiments leading to reliability modeling (K3&K4).

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 techniques.

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.

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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.

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.

UNIT V

RELIABILITY: Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

TEXT BOOKS:

1. Optimization for Engineering Design – Kalyanmoy 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 Kalyanmoy Deb, PHI Publishers.

REFERENCES:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison- Wesley Publishers
2. Multi objective Genetic algorithms - Kalyanmoy 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

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I Year I Semester	NANO TECHNOLOGY (PROGRAM ELECTIVE-2) (25AM1D06)	L	T	P	C
		3	0	0	3

Course Objectives

The course is designed to:

1. Introduce students to the fundamental concepts of nanotechnology and how material properties change at the nanoscale.
2. Provide knowledge of nanomaterial synthesis techniques including top-down and bottom-up approaches.
3. Familiarize students with various tools used for imaging and characterization of nanostructures.
4. Explore the synthesis, properties, and applications of metal, semiconductor nanoparticles, and nanowires.
5. Understand the structure, properties, and technological potential of carbon nanotubes in modern applications.

Course Outcomes (COs)

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

CO No.	Course Outcome	Bloom's Level
CO1	Describe nanoscale phenomena and how material properties change with size, and explain the working principles of nanosystems.	Understand
CO2	Explain and compare various nanomaterial synthesis techniques used in top-down and bottom-up nanofabrication.	Understand / Analyze
CO3	Identify and apply appropriate imaging and characterization techniques for analyzing nanostructures.	Apply
CO4	Analyze the synthesis methods and functional applications of nanoparticles and nanowires in electronics, bioengineering, and catalysis.	Analyze / Evaluate
CO5	Evaluate the unique properties and potential applications of carbon nanotubes in electronic and structural systems.	Evaluate

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UNIT-I:

Introduction, Size and shape dependence of material properties at the nanoscale, scaling relations, can nanorobots walk and nanoplanes fly, Nano scale elements in conventional technologies, Mechanics at nanoscale Enhancement of mechanical properties with decreasing size, Nanoelectromechanical systems, nano machines, Nano fluidics, filtration, sorting, Molecular motors, Application of Nano Technology.

UNIT-II:

Nano material Synthesis Techniques: Top-down and bottom-up nanofabrication, Synthesis of nano composites, The Intel-IBM approach to nanotechnology: lithography, etching, ion implantation, thin film deposition, nano coatings and nano indentation, Electron beam lithography, Soft lithography: nanoimprinting and micro-contact printing, Solution/plasma-phase nanofabrication, sol-gel methods, template techniques.

UNIT-III:

Imaging/characterization of nanostructures General considerations for imaging, scanning probe techniques: XRD, SEM, TEM, AFM and NSOM.

UNIT-IV:

Metal and semiconductor nanoparticles Synthesis, stability, control of size, Optical and electronic properties, Ultra-sensitive imaging and detection with nano particles, bioengineering applications, Catalysis. Semiconductor and metal nanowires Vapor/liquid/solid growth and other synthesis techniques, Nanowire transistors and sensors.

UNIT-V:

Carbon nanotubes Structure and synthesis, Electronic, vibrational, and mechanical properties, how can C nanotubes enable faster computers, brighter TV screens, and stronger mechanical reinforcement?

TEXT BOOKS:

1. Nanoscale Science and Technology by Kelsall, Hamley, and Geoghegan, Wiley (2005)
2. Introduction to Nanoscale Science and Technology by Di Ventra, Evoy, and Heflin, Kluwer Academic Publishers (2004).

REFERENCES:

1. Introduction to Nanotechnology by Poole and Owens, Wiley (2003)
2. Nanochemistry: A Chemical Approach to Nanomaterials, Ozin and Arsenault, RSC Publishing (2006).

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I Year I Semester	PRECISION ENGINEERING (PROGRAM ELECTIVE-2) (25AM1D07)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Understand accuracy and precision and learn how to test and improve machine tool alignment and part accuracy.
2. Learn different precision manufacturing methods and surface finishing techniques.
3. Understand various measurement tools and techniques used to check dimensions and surface quality.
4. Learn the basics of nanotechnology and its applications in manufacturing tiny parts and materials.
5. 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:

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).

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.

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.

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

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.

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,

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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:

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I Year I Semester	ADDITIVE MANUFACTURING (PROGRAM ELECTIVE-2) (25AM1D08)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

COURSE OUTCOMES:

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

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).

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. 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. 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 Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOMand UC applications, case studies. Powder Bed Fusion AM Processes: Selective laser Sintering(SLS),Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, 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. 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. 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.

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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:

- https://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

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I Year I Semester	ADVANCED CAD LAB (25AM1L01)	L	T	P	C
		0	0	4	2

Course Objectives

The objectives of this lab course are to:

1. Develop skills in advanced 3D modeling techniques including solid and surface modeling.
2. Enable students to perform assembly and disassembly of complex mechanical systems using CAD tools.
3. Impart knowledge on applying dimensional, form, and assembly tolerances in CAD models.
4. Introduce students to Finite Element (FE) analysis of structural components in 1D, 2D, and 3D.
5. Enhance proficiency in using CAD and FEA software tools for design validation and simulation.

Course Outcomes (COs)

Upon successful completion of this lab, students will be able to:

CO No.	Course Outcome	Bloom's Level
CO1	Create accurate 3D models using solid and surface modeling techniques.	Apply
CO2	Assemble and disassemble mechanical components using CAD software.	Apply / Analyze
CO3	Apply appropriate dimensional, form, and assembly tolerances in CAD models.	Apply
CO4	Perform basic Finite Element Analysis (FEA) on 1D, 2D, and 3D structural components.	Apply / Analyze
CO5	Interpret FEA results to validate mechanical designs under different loading conditions.	Analyze / Evaluate

Students shall carry out the modeling of the following:

1. Product Modelling- Surface Modelling and Solid modelling
2. Assembly of different mechanical components
3. Disassembly of different mechanical components
4. Dimensional and Form Tolerances
5. Assembly tolerances
6. FE Analysis of 1Dstructural components
7. FE Analysis of 2D structural components
8. FE Analysis of 3D structural components

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BONAM VENKATA CHALAMAYYA ENGINEERING COLLEGE
(*An Autonomous Institution*)
Department of Mechanical Engineering
M. TECH (BR25) ADVANCED MANUFACTURING SYSTEMS
COURSE STRUCTURE & SYLLABUS

I Year I Semester	ADVANCED MANUFACTURING LAB (25AM1L02)	L	T	P	C
		0	0	4	2

Course Objectives

The objectives of the Advanced Manufacturing Lab are to:

1. Provide hands-on experience in the fabrication of components using conventional manufacturing processes like casting, forging, forming, and welding.
2. Introduce the application of powder metallurgy techniques and evaluate sintering characteristics.
3. Expose students to additive manufacturing technologies such as 3D printing for component fabrication.
4. Enable students to measure and analyze machining performance parameters such as chip reduction, shear angle, cutting forces, and tool life.
5. Develop the ability to select appropriate manufacturing processes for different engineering applications based on process characteristics and output quality.

Course Outcomes (COs)

Upon successful completion of this lab course, students will be able to:

CO No.	Course Outcome	Bloom's Level
CO1	Fabricate mechanical components using metal casting, forging, forming, and welding processes.	Apply
CO2	Analyze the fabrication process in powder metallurgy and calculate green and sintered densities.	Apply / Analyze
CO3	Operate additive manufacturing equipment (3D printing) to fabricate simple components.	Apply
CO4	Perform metal cutting experiments and evaluate parameters like chip reduction coefficient, shear angle, cutting forces, and tool life.	Apply / Analyze
CO5	Select and justify suitable manufacturing processes for specific applications based on material, geometry, and functional needs.	Analyze / Evaluate

Students shall carry out the experiments on the following:

1. Fabrication of component through any metal Casting processes
2. Fabrication of component through any Forging processes
3. Fabrication of component through any Forming Processes –blanking, bending and deep

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drawing
4. Fabrication of a Weldment – arc, gas or spot-welding processes
5. Fabrication of component through Powder metallurgy- Calculation of Green Density and sintering density
6. Fabrication of component through Additive Manufacturing –simple parts in 3D printing
7. Metal removal using a Machining process - Estimation of chip reduction coefficient and shear angle in orthogonal turning, Measurement of cutting forces and average cutting temperature, and Estimation of tool life of a single point turning tool.

[signature]	online	online	online	Online	[signature]
Dr. M. Kumara Swamy Assoc. Professor, Dept. of ME, UCEK (A), JNTUK	Dr. M. Ravi Sankar Prof. & Head, Dept. of ME, IITTP	Dr. T. Babu Rao, Asst. Professor, Dept. of ME, NITAP	Mr. K. M. Dakshina Murty, Sr. DGM, BHEL-HYD	Mr. U. Srinivas Technical officer C, ISRO-SHAR, Sriharikota	Dr. M. Naveen Srinivas, HOD-ME, BVCE(A)
Member-Affiliating Univ. Nominee	Subject Expert	Subject Expert	Industry Expert	PG Alumni	Chair-person BOS

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