Department	MECHANICAL ENGINEERING					Semester			I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMAB101T	APPLIED PROBABILITY AND STATISTICS	3	1	0	60	4	50	50	100

Course Objective (s):

- To train the students so that students will be able to design experimental designs and use these concepts for research design.
- To introduce the concept of probability so that they can be used for industrial applications.
- To stress upon the importance of the sampling theory and its usefulness in industrial quality control.
- To make students familiarize with the concepts of estimation theory and its applications.
- To help students the usefulness of test of significance and its applications in industry and research.

Course Outcomes:

CO1 : Apply the concepts of probability to industrial and research problems.
CO2 : Apply the concept of sampling techniques, so that they can be used for industrial applications.
CO3 : To use estimation theory and its usefulness in industrial quality control.
CO4 : Apply the concepts of testing of hypothesis to industrial problems.
CO5 : Apply techniques of ANNOVA to industry and research.

Unit I	PROBABILITY THEORY	13

Random variables – probability density and distribution functions-moment generating and characteristic functions – Binomial, Poisson, Normal distributions and their applications.

Unit II	SAMPLING THEORY	13

Sampling distributions – Standard error – t, F, Chi square distributions – applications.

Unit III	ESTIMATION THEORY	6

Interval estimation for population mean, standard deviation, difference in means, preparation ratio of standard deviations and variances.

Unit IV	TESTING OF HYPOTHESIS AND ANOVA	8

Hypothesis testing – Small samples – Tests concerning proportion, means, standard deviations – Tests based on chi square – and Redistribution - test One, two factor models-Design of experiments.

Unit V	ANOVA	5

Design of experiments – One, Two factor Models

REFERENCES:

1. Morris H Dcrort and Mark J Schervish, Probability and Statistics, Pearson Education, 2018.
2. Vijay K Rohatgi and Md.Ehsanes A K Saleh, An Introduction to Probability and Statistics, Wiley, 3rd Edition.2015.
3. Gupta S.C and Kapoor V.K, Fundamentals of Applied Statistics, Sultan Chand, 2014.
4. John.E Freunds, Mathematical statistics with applications, Pearson Education, India, 8th Edition, 2013
5. Levin I. and Rubin S, Statistics for Management, Pearson Education India, 7th Edition, 2012.

Department	MECHANICAL ENGINEERING					Semester		I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks	
		L	T	P		C	CA	ES	Total
19PMEC101T	ADVANCED MATERIALS TECHNOLOGY	3	0	0	45	3	50	50	100

Course Objective (s):

- To make the students to understand on elastic, plastic and fractured behavior of engineering materials.
- To train the students in selection of metallic and non-metallic materials for the various engineering applications.

Course Outcomes:

- To impart knowledge on the advanced concepts of material technology

Unit I	ELASTIC AND PLASTIC BEHAVIOR	10

Elasticity in metals and polymers Anelastic and visco-elastic behaviour – Mechanism of plastic deformation and non metallic shear strength of perfect and real crystals – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – Deformation of non crystalline materials.

Unit II	FRACTURE BEHAVIOUR	10

Griffith's theory, stress intensity factor and fracture toughness – Toughening mechanisms – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law. Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

Unit III	SELECTION OF MATERIALS	10

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.

Unit IV	MODERN METALLIC MATERIALS	8

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

Unit V	NON METALLIC MATERIALS	7

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al_2O3, SiC, Si_3N_4 CBN and diamond – properties, processing and applications.

REFERENCES:

1. Ashby M.F., Material Selection in Mechanical Design, 3rd Edition, Butter Worth 2005.
2. ASM Hand book, Vol.11, Failure Analysis and Prevention, (10th Edition), ASM, 2002.
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (3rd edition), Butterworth-Heiremann, 2001.
4. Thomas H. Courtney, Mechanical Behaviour of Materials, (2nd edition), McGraw Hill, 2000
5. George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988

Department	MECHANICAL ENGINEERING					Semester			I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC102T	AUTOMATED COMPUTER INTEGRATED MANUFACTURING L SYSTEM	3	0	0	45	3	50	50	100

Course Objective (s):

- To teach the role of computers in processing of information knowing across the various stages and various departments in a manufacturing industries
- To train them in process planning.

Course Outcomes:

- To expose the students on the need of automation and integration

Unit I	INTRODUCTION	6

Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM – CIM wheel and cycle – Production concepts and mathematical models – Simple problems in production models – CIM hardware and software – Major elements of CIM system – Three step process for implementation of CIM – Computers in CIM – Computer networks for manufacturing – The future automated factory – Management of CIM – Impact of CIM on personnel – CIM status.

Unit II	AUTOMATED MANUFACTURING SYSTEMS	10

Automated production line – system configurations, work part transfer mechanisms – Fundamentals of Automated assembly system – System configuration, Part delivery at workstations – Design for automated assembly – Overview of material handling equipments – Consideration in material handling system design – The 10 principles of Material handling. Conveyor systems – Types of conveyors – Operations and features.

Automated Guided Vehicle system – Types of vehicles and AGVs applications – Vehicle guidance technology – Vehicle management and safety.

Storage system performance – storage location strategies – Conventional storage methods and equipments – Automated storage/Retrieval system and Carousel storage system Deadlocks in Automated manufacturing systems – Petrinet models – Applications in Dead lock avoidance.

Unit III	GROUP TECHNOLOGY AND FMS	10

Part families – Visual – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies.

FMS – Components – workstations – FMS layout configurations – Computer control systems – FMS planning and implementation issues – Architecture of FMS – flow chart showing various operations in FMS – Machine cell design – Composite part concept, Holier method, Key machine concept – Quantitative analysis of FMS – Bottleneck model – Simple and complicated problems – Extended Bottleneck model - sizing the FMS – FMS applications, Benefits.

Unit IV	PROCESS PLANNING	10

Process planning – Activities in process planning, Informations required. From design to process planning – classification of manufacturing processes Selection of primary manufacturing processes – selecting among casting process, forming process and machining process. Sequencing of operations according to Anteriorities – various examples – forming of Matrix of Anteriorities – case study. Typical process sheet – case studies in Manual process planning.

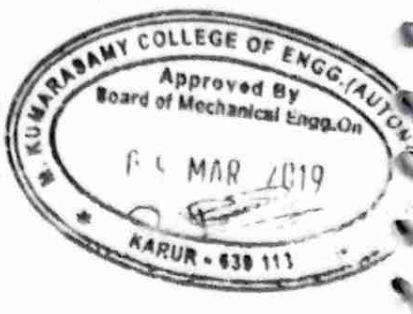
Computer Aided Process Planning – Process planning module and data base – Variant process planning – Two stages in VPP – Generative process planning – Flow chart showing various activities in generative PP – Semi generative process planning.

Unit V	TYPES OF PROCESS CONTROL AND AUTOMATIC DATA CAPTURE	9

Introduction to process model formulation – linear feed back control systems – Optimal control – Adaptive control –Sequence control and PLC. Computer process control – Computer process interface – Interface hardware – Computer process monitoring – Direct digital control and Supervisory computer control.

Overview of Automatic identification methods – Bar code technology – Other Automatic data capture technologies.

REFERENCES:	
1	Alavudeen and Venkateshwaran, -Computer Integrated Manufacturingl, PHI Learning Pvt. Ltd., New Delhi, 2008.
2	Mikell P.Groover, -Automation, Production system and Computer integrated Manufacturingl, Prentice Hall of India Pvt. Ltd., 2008.
3	Kant Vajpayee,S., -Computer Integrated Manufacturingl, Prentice Hall of India, New Delhi, 2007
4	James A.Retrg, Herry W.Kraebber, -Computer Integrated Manufacturingl, Pearson Education, Asia, 2001.
5	Viswanathan,N., and Narahari,Y., -Performance Modeling and Automated Manufacturing Systemsl, Prentice Hall of India Pvt. Ltd., 2000.
6	Radhakrishnan,P., Subramanian,S., and Raju,V., -CAD/CAM/CIMl New Age International Publishers, 2000.



Department	MECHANICAL ENGINEERING					Semester			I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC103T	MODERN MANUFACTURING PROCESSES	3	0	0	45	3	50	50	100

Course Objective (s):

- To create awareness on Abrasive aided machining
- To understand electrical and electrochemical machining processes.
- To analyse the principles of high energy aided machining.
- To study the surface and bulk machining processes of silicon wafer.
- To introduce students to the major manufacture steps in electronic circuit boards.

Course Outcomes:

CO1 : Understand and grasp the significance of modern machining process and its applications.
CO2 : Identify the selection of machining process and its parameters.
CO3 : Express and appreciate the cutting edge technologies and apply the same for research purposes.
CO4 : Measure the stages involved in fabrication of micro devices.
CO5 : Create new devices involved in micro fabrication and recent technology.

Unit I	ABRASIVE AIDED MACHINING PROCESSES	9

Abrasive machining – water jet machining - ultrasonic machining –Abrasive flow machining- Magneto rheological Abrasive flow machining- construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications .

Unit II	ELECTRICAL AND CHEMICAL AIDED MACHINING PROCESSES	9

Wire cut EDM - Electric discharge machining – Electrochemical machining – chemical machining – Maskants - Electrochemical grinding - construction – principle – types – control - circuits – tool design – merits, demerits and applications. Hybrid Machining.

Unit III	HIGH ENERGY AIDED MACHINING PROCESSES	9

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.

Unit IV	FABRICATION OF MICRO DEVICES	9

Semiconductors – Si wafer - planarization – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process

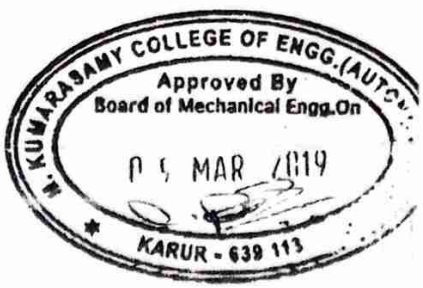
Unit V	MICROFABRICATION TECHNOLOGY	9

Moulding – PCB board hybrid and MCM technology – programmable devices and ASIC – electronic material and processing– stereolithography – Solid free form fabrication -SAW devices, Surface Mount Technology.

TOTAL: 45 HOURS

REFERENCES:

1. Brahem T. Smith, Advanced Machining I.F.S. UK 2016.
2. Jaeger R.C., Introduction to Microelectronic Fabrication Addison Wesley, 2nd Edition,1998.
3. Jain V K, Micromanufacturing Processes, CRC Press, 2012.
4. Julian W. Gardner, Vijay K Varadan and Osama O Awadelkarim, Microsensors MEMS and Smart devices, John Willey, 2013.
5. Pandey P.C. and Shan HS Modern Machining Processes, Standard Publishing Co., 1st Edition,1980.
6. Serope Kalpakjian and Steven R. Schmid- Manufacturing Process for Engineering Material – Pearson Education, 6th Edition, 2018



Regulation 2019		Semester I	Total Hours			30
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
M	19PATM101	Research Methodology and IPR	2	0	0	2

Prerequisite Course (s)

Nil

Course Objective (s):

The purpose of learning this course is to:

1	Understand and analyse the fundamental of research problem
2	Understand the Research Ethics
3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
4	Understand Intellectual Property Rights
5	Understand Patents Rights

Course Outcome (s) (COs):

At the end of this course, learners will be able to:

CO1	Understand research problem formulation
CO2	Analyze research related information
CO3	Follow research ethics
CO4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular
CO5	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

UNIT I	INTRODUCTION	6

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.

UNIT II	ANALYSIS OF REARCH	6

Approaches of investigation of solutions for research problem- data collection- analysis- interpretation- Necessary instrumentations Effective literature studies approaches- analysis Plagiarism,- Research ethics.

UNIT III	RESEACRH PRPOSAL AND TECHNICAL WRITING	6

Effective technical writing - how to write report-Paper Developing a Research Proposal- Format of research proposal- a presentation and assessment by a review committee.

UNIT IV	INTELLECTUAL PROPERTY	6

Nature of Intellectual Property: Patents Designs Trade and Copyright- Process of Patenting and

Development: technological research- innovation- patenting- And development. International Scenario: International cooperation on Intellectual Property- Procedure for grants of patents- Patenting under PCT.		
UNIT V	PATENTS RIGHTS	6
Patent Rights: Scope of Patent Rights- Licensing and transfer of technology -Patent information and databases- Geographical Indications.		
Text Book (s)		
1	Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".	
2	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007	
Reference (s)		
1	Ranjit Kumar, 2 nd Edition , "Research Methodology: A Step by Step Guide for beginners"	
2	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008	
3	Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.	
4	Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"	

Department	MECHANICAL ENGINEERING					Semester			I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC104T	ROBOT DESIGN & PROGRAMMING	3	0	0	45	3	50	50	100

Course Objective (s):

- To teach the students about the kinematic arrangement of robots and its applications in the area of manufacturing sectors
- To expose the students to build a robot for any type of application

Course Outcomes:

- To impart knowledge in the area of Robot designing and programming in Robotic languages.

Unit I	INTRODUCTION	9

Definition, Need Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence, specifications of robot, degrees of freedoms, end effectors – types, selection applications.

Unit II	ROBOT KINEMATICS	9

Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenbers representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames:

Unit III	ROBOT DYNAMICS AND TRAJECTORY PLANNING	9

Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning

Unit IV	ROBOT PROGRAMMING & AI TECHNIQUES	9

Types of Programming – Teach Pendant programming – Basic concepts in A1 techniques – Concept of knowledge representations – Expert system and its components.

Unit V	ROBOT SENSORS AND ACTUATORS	9

Design of Robots – characteristics of actuating systems, comparison, microprocessors control of electric motors, magnetostrictive actuators, shape memory type metals, sensors, position, velocity, force, temperature, pressure sensors – Contact and non contact sensors, infrared sensors, RCC, vision sensors.

TOTAL: 45 HOURS

REFERENCES:

1	Saeed.B.Niku, 'Introduction to Robotics, Analysis, system, Applications', Pearson educations, 2010.
2	Groover.M.P. Industrial Robotics, McGraw – Hill International edition, 1996.
3	Wesley E Snyder R, 'Industrial Robots, Computer Interfacing and Control', Prentice Hall International Edition, 2013.
4	Gordon Mair, 'Industrial Robotics', Prentice Hall (U.K.) 1988
	John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 3rd edition, 2004.
	Fu K S, Gonzalez, Lee C S G, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill *Book* Company, 1987.

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Department	MECHANICAL ENGINEERING					Semester			I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC105L	CAD / CAM LABORATORY	0	0	4	60	2	70	30	100

Course Objective (s):

- To teach the students about the drafting of 3D components and analyzing the same using various CAD packages and programming of CNC machines
- To train them to use the various sensors

Course Outcomes:

- To impart the knowledge on training the students in the area of CAD/CAM

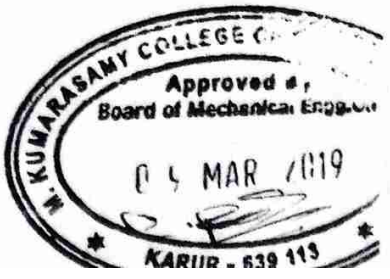
CAM LABORATORY — 30

1. Exercise on CNC Lathe: Plain Turning, Step turning, Taper turning, Threading, Grooving & canned cycle
2. Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling & canned cycle.
3. Study of Sensors, Transducers & PLC: Hall-effect sensor, Pressure sensors, Strain gauge, PLC, LVDT, Load cell, Angular potentiometer, Torque, Temperature & Optical Transducers.

CAD LABORATORY — 30

2D modeling and 3D modeling of components such as

1. Bearing
2. Couplings
3. Gears
4. Sheet metal components
5. Jigs, Fixtures and Die assemblies.



Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC106T	OPTIMIZATION TECHNIQUES IN MANUFACTURING	3	0	0	45	3	50	50	100

Course Objective (s):

- To make use of the above techniques while modeling and solving the engineering problems of different fields.

Course Outcomes:

- To introduce the various optimization techniques and their advancements.

Unit I	**INTRODUCTION**	5

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

Unit II	**CLASSIC OPTIMIZATION TECHNIQUES**	10

Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

Unit III	**NON-LINEAR PROGRAMMING**	9

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming.

Unit IV	**INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES**	12

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

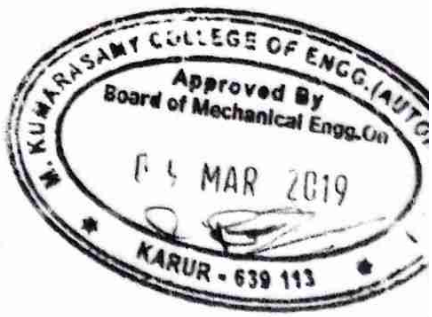
Unit V	**ADVANCES IN SIMULATION**	9

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

TOTAL: 45 HOURS

REFERENCES:

1	R. Panneerselvam, -Operations Researchl, Prentice Hall of India Private Limited, New Delhi 1 2005.
2	J.K.Sharma, Operations Research – Theory and Applications – Macmillan India Ltd., 1997
3	Hamdy A. Taha, Operations Research – An Introduction, Prentice Hall of India, 1997
4	P.K. Guptha and Man-Mohan, Problems in Operations Research – Sultan chand & Sons, 1994
5	Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992



Department	MECHANICAL ENGINEERING					Semester		II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks	
		L	T	P		C	CA	ES	Total
19PMEC107T	MANUFACTURING METROLOGY AND QUALITY ENGINEERING	3	0	0	45	3	50	50	100

Course Objective (s):

- To impart through knowledge in various latest measurement systems such as laser metrology, coordinate measuring machines and electro-optical devices.
- To train them in the area of precision and quality manufacturing

Course Outcomes:

- To expose the students, the importance of measurement and the various latest measuring techniques using Laser, Coordinate measuring machines and Opto-electronics devices. Also to stress upon the Importance of quality in manufacturing.

Unit I	LASER METROLOGY AND PRECISION INSTRUMENTS	9

Introduction – types of lasers – laser in engineering metrology – metrological laser methods for applications in machine systems – Interferometry applications – speckle interferometry – laser interferometers in manufacturing and machine tool alignment testing – laser Doppler technique – laser Doppler anemometry - Laser telemetric systems – detection of microscopic imperfections on high quality surface Pitter NPL gauge interferometer – classification of optical scanning systems – high inertia laser scan technique – rotating mirror technique vibrational deflectors – refractive and diffractive scanners. – laser gauging – bar coding – laser dimensional measurement system.

Unit II	CO-ORDINATE MEASURING SYSTEM	9

Co-ordinate metrology – CMM configurations – hardware components – software – Probe sensors – Displacement devices – performance evaluations – software – hardware – dynamic errors – thermal effects diagram – temperature variations - environment control – applications – Roll of CMM in reverse engineering.

Unit III	OPTO ELECTRONICS AND VISION SYSTEM	9

Opto electronic devices – CCD – On-line and in-process monitoring in production - applications - image analysis and computer vision – Image analysis techniques – spatical feature – Image extraction – segmentation – digital image processing – Vision system for measurement – Comparison laser scanning with vision system.

Unit IV	QUALITY IN MANUFACTURING AND DESIGN ENGINEERING	9

Importance of manufacturing planning for quality – initial planning and concept of quality – self controls – defining quality responsibilities on the factory flow – automated manufacturing – overall view of manufacturing planning – process quality audits – Opportunities for improvement in product design – early warning concepts and design assurance – design for basic functional requirements – design for reliability – availability – designing for manufacturability and safety – cost of quality – design review - concurrent engineering – improving the effectiveness of product development.

Unit V	QUALITY MANAGEMENT SYSTEM AND CONTINUOUS IMPROVEMENT	9

Need for quality management system – design of quality management system – quality management system requirements – ISO 9001 and other management system and models – basic quality engineering tools - statistical process control – techniques for process design and improvement – Taguchi methods for process improvement – six sigma.

TOTAL: 45 HOURS

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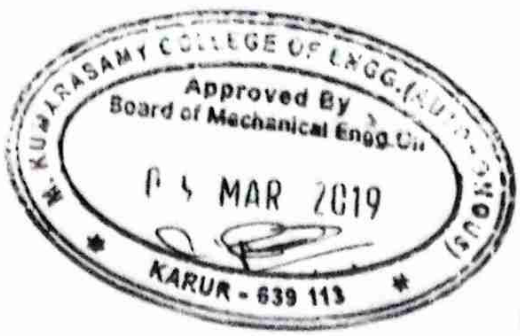
REFERENCES:	
1	Oakland J.S. Total Quality Management – Text with cases, Butter worth – Heinemann – An imprint of Elseiver, First Indian Print, New Delhi 2005.
2	Elanchezhian.C, Vijaya Ramnath.B and Sunder Selwyn, T., Engineering Metrology, Eswar Press, Chennai, 2004.
3	Zuech Nello, Understanding and Applying Machine Vision, Marcel Dekker, Inc, 2000
4	John A. Bosch, Giddings and Lewis Dayton, Co-ordinate Measuring Machines and Systems, Marcel Dekker, Inc, 1999.
5	Juran J.M. and Gyna F.M., Quality Planning and Analysis, Tata-McGraw Hill, New Delhi, 1995. Awcock, G.J. and Thomas R, Applied Image Processing, Mc.Graw Hill, Inc. 1996.



Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC108T	THEORY OF METAL FORMING	3	0	0	45	3	50	50	100

Course Objective (s):

- To study the basic concepts of metal forming techniques and to develop force calculation in metal forming process.
- To study the thermo mechanical regimes and its requirements of metal forming.

Course Outcomes:

- To impart knowledge on plasticity, surface treatment for forming of various types of metal forming process.

Unit I	THEORY OF PLASTICITY	9

Theory of plastic deformation – Yield criteria – Tresca and Von-mises – Distortion energy – Stress- strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – Overview of FEM applications in Metal Forming analysis.

Unit II	THEORY AND PRACTICE OF BULK FORMING PROCESSES	9

Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming.

Unit III	SHEET METAL FORMING	9

Formability studies – Conventional processes – H E R F techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application.

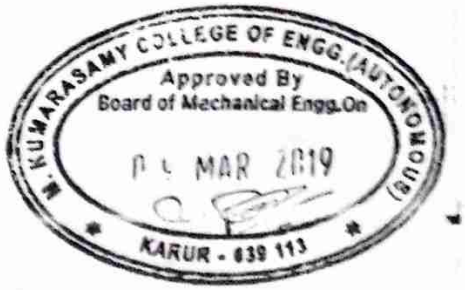
Unit IV	POWDER METALLURGY AND SPECIAL FORMING PROCESSES	9

Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming.

Unit V	SURFACE TREATMENT AND METAL FORMING APPLICATIONS	9

Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and gliding velocity – Friction heat generation – Friction between metallic layers – Lubrication carrier layer – Surface treatment for drawing, sheet metal forming, Extrusion, hot and cold forging.Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.

TOTAL: 45 HOURS



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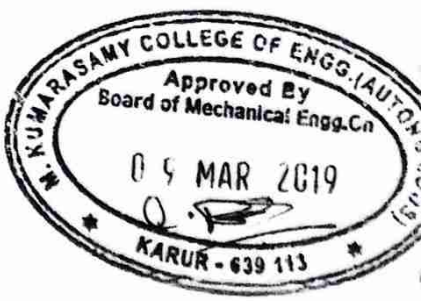
1	Helmi A Youssef, Hassan A. El-Hofy, Manufacturing Technology: Materials, Processes and Equipment, CRC publication press, 2012.
2	SAE Transactions, Journal of Materials and Manufacturing Section 5, 1993-2007
3	Surender kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers,2010
4	Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elesevier, 2006
5	Nagpal G.R., Metal Forming Processes- Khanna publishers, 2005.
6	Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003



Department	MECHANICAL ENGINEERING					Semester		II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks	
		L	T	P		C	CA	ES	Total
19PMEC109T	MATERIAL TESTING AND CHARACTERIZATION TECHNIQUES	3	0	0	45	3	50	50	100

Course Objective (s):
On completion of the course the students are expected to be knowledgeable in microstructure evaluation, crystal structure analysis, electron microscopy, Chemical Thermal Analysis, static and dynamic mechanical testing methods.

Course Outcomes:
This course aims to impart knowledge on various techniques of material characterization.

Unit I	MICRO AND CRYSTAL STRUCTURE ANALYSIS	10

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

Unit II	ELECTRON MICROSCOPY	9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications .

Unit III	CHEMICAL AND THERMAL ANALYSIS	10

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravitymetric Analysis (TGA).

Unit IV	MECHANICAL TESTING – STATIC TESTS	8

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

Unit V	MECHANICAL TESTING – DYNAMIC TESTS	9

Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

TOTAL: 45 HOURS

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Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEC110L	AUTOMATION AND METAL FORMING LABORATORY	0	0	4	60	2	70	30	100

Course Objective (s):

- To train the students to have an hands on having the basic concepts of metal forming processes and to determine some metal forming parameters for a given shape.

Course Outcomes:

To impart practical knowledge on bulk metal forming and sheet metal forming processes.

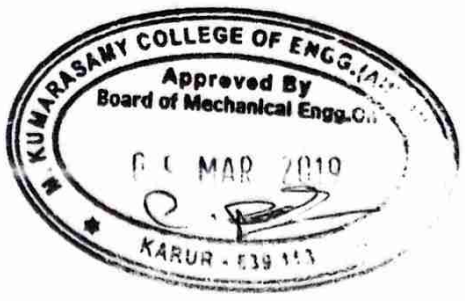
EXPERIMENTS — 30

1. Determination of strain hardening exponent
2. Determination of strain rate sensitivity index
3. Construction of formability limit diagram
4. Determination of efficiency in water hammer forming
5. Determination of interface friction factor
6. Determination of extrusion load
7. Study on two high rolling process

AUTOMATION LAB — 30

1. Simulation of single and double acting cylinder circuits
2. Simulation of Hydraulic circuits
3. Simulation of electro pneumatic circuits
4. Simulation of electro hydraulic circuits
5. Simulation of PLC circuits
6. Software simulation of fluid power circuits using Automation studio.

TOTAL: 45 HOURS



Department	MECHANICAL ENGINEERING					Semester			I
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEE003T	ADVANCES IN CASTING AND WELDING	3	0	0	45	3	50	50	100

Course Objective (s):

- To refresh the knowledge on basic concepts and to impart knowledge on advances in casting and welding processes.

Course Outcomes:

- To study the metallurgical concepts and applications of casting and welding process.
- To acquire knowledge in CAD of casting and automation of welding process.

Unit I	**CASTING DESIGN**	**8**

Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and risering

Unit II	**CASTING METALLURGY**	**8**

Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification — Degasification of the melt-casting defects – Castability of steel , Cast Iron, Al alloys , Babbit alloy and Cu alloy.

Unit III	**RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT**	**8**

Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel, aluminum, Mg , Cu , Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control . Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.

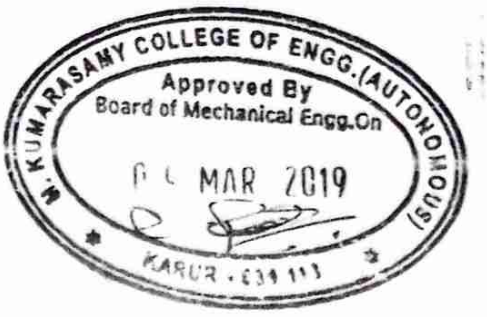
Unit IV	**WELDING METALLURGY AND DESIGN**	**10**

Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

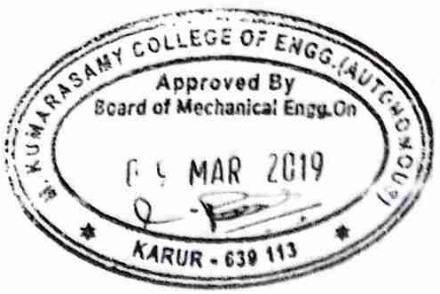
Unit V	**RECENT TRENDS IN WELDING**	**11**

Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding – Electroslag welding- narrow gap, hybrid twin wire active TIG – Tandem MIG- modern brazing and soldering techniques – induction, dip resistance, diffusion processes – Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

TOTAL: 45 HOURS



REFERENCES:	
1.	ASM Handbook, Vol 15, Casting, 2004
2.	ASM Handbook vol.6, welding Brazing & Soldering, 2003
3.	Alex Krulikowski, -Fundamentals GD&TI, Delmar Thomson Learning, 1997.
4.	Oliver R. Wade, -Tolerance Control in Design and Manufacturingl, Industrial Press, NY, 1967.
5.	James G. Bralla, -Handbook of Product Design for Manufacturingl, McGraw Hill, 1986.



Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEE009T	POLYMERS AND COMPOSITE MATERIALS	3	0	0	45	3	50	50	100

Course Objective (s):

- To study matrix material, reinforcements of polymer matrix composites, MMC and ceramic matrix composites.
- To develop knowledge on processing, interfacial properties and application of composites

Course Outcomes:

- To impart knowledge on types, physical properties and processing of polymer matrix composites, metal matrix composites and ceramics matrix composite.

Unit I	PROCESSING OF POLYMERS	9

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

Unit II	FIBERS AND MATRIX MATERIALS	9

Fibers – Fabrication, Structure, properties and applications – Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic and metallic fibers - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface – Tests for measuring interfacial strength - Physical and chemical properties.

Unit III	PROCESSING OF POLYMER MATRIX COMPOSITES	9

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs - structure, properties and application of PMCs –recycling of PMCs.

Unit IV	PROCESSING OF METAL MATRIX COMPOSITES	9

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

Unit V	PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES	9

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques chemical vapour deposition, chemical vapour impregnation, sol-gel – interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites – applications

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REFERENCES:

1.	Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer,2012, ISBN:978-0-387-74364-6.
2.	Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010, ISBN:0849342058.
3.	Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009. ISBN: 978-0- 387-35539-9.
4.	Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers, 2003. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.
5.	Seamour, E.B. Modern Plastics Technology, Prentice Hall, 2002 Said Jahanmir, Ramulu M. and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999, ISBN: 0-8247-0178-x. ASM Handbook – Composites, Vol-21, 2001, ISBN: 978-0-87170-703-1.

Department	MECHANICAL ENGINEERING					Semester			II
Course Code	Course Name	Hours / Week			Total Hours	Credit	Maximum Marks		
		L	T	P		C	CA	ES	Total
19PMEE010T	NON-DESTRUCTIVE EVALUATION	3	0	0	45	3	50	50	100

Course Objective (s):

- To introduce all types of NDT and their applications in Engineering.

Course Outcomes:

- To stress the importance of NDT in engineering

Unit I	NON-DESTRUCTIVE TESTING AND PRODUCTION, VISUAL INSPECTION & LIQUID PENETRANT TESTING.	9

Introduction to various non-destructive methods, Comparison of Destructive and Non destructive Tests, Visual Inspection, Optical aids used for visual inspection, Applications. Physical principles, procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods-water washable, Post – Emulsification methods, Applications

Unit II	EDDY CURRENT TESTING & ACOUSTIC EMISSION	9

Principles, Instrumentation for ECT, Absolute, differential probes, Techniques – High sensitivity techniques, Multi frequency, Phased array ECT, Applications.
Principle of AET, Instrumentation, Applications - testing of metal pressure vessels, Fatigue crack detection in aerospace structures

Unit III	MAGNETIC PARTICLE TESTING & THERMOGRAPHY	9

Principle of MPT, procedure used for testing a component, Equipment used for MPT, Magnetizing techniques, Applications.
Principle of Thermography, Infrared Radiometry, Active thermography measurements, Applications – Imaging entrapped water under an epoxy coating, Detection of carbon fiber contaminants.

Unit IV	ULTRASONIC TESTING	9

Principle, Ultrasonic transducers, Ultrasonic Flaw detection Equipment, Modes of display A- scan, B-Scan, C- Scan, Applications, Inspection Methods- Normal Incident Pulse-Echo Inspection, Normal Incident Through-transmission Testing, Angle Beam Pulse-Echo testing, TOFD Technique, Applications of Normal Beam Inspection in detecting fatigue cracks, Inclusions, Slag, Porosity and Intergranular cracks - Codes, standards, specification and procedures and case studies in ultrasonics test.

Unit V	RADIOGRAPHY	9

Principle of Radiography, x-ray and gamma ray sources- safety procedures and standards, Effect of radiation on Film, Radiographic imaging, Inspection Techniques – Single wall single image, Double wall Penetration, Multiwall Penetration technique, Real Time Radiography - Codes, standards, specification and procedures and case studies in Radiography test.
Case studies on defects in cast, rolled, extruded, welded and heat treated components - Comparison and selection of various NDT techniques

TOTAL : 45 HOURS

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REFERENCES:	
1.	Baldev Raj, Jeyakumar,T., Thavasimuthu,M., -Practical Non Destructive Testingl Narosa publishing house, New Delhi, 2002
2.	Peter J. Shull -Non Destructive Evaluation: Theory, Techniques and Applicationl Marcel ekker,
3.	Inc., New York, 2002 Krautkramer. J., -Ultra Sonic Testing of Materialsl, 1st Edition, Springer – Verlag Publication, New York, 1996. www.ndt.net

Regulation 2019		Semester II	Total Hours			15
Category	Course Code	Course Name	Hours / Week			C
			L	T	P	
M	19PATM102	English For Research Paper Writing	1	0	0	0

Prerequisite Course (s)

Nil

Course Objective (s):

The purpose of learning this course is to:

1	Understand that how to improve your writing skills and level of readability
2	Learn about what to write in each section
3	Understand the skills needed when writing a Title

Course Outcome (s) (COs):

At the end of this course, learners will be able to:

CO1	Understand the basics of writing skills
CO2	Illustrate the level of readability
CO3	Explain about what to write in each section
CO4	Summarize the skills needed to form a title

UNIT I	3

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II	3

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III	3

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV	3

Key skills are needed when writing a title, Key skills are needed when writing an abstract, Key skills are needed when writing an introduction, Skills needed when writing a review of the literature

UNIT V	3

Skills are needed when writing the methods, Skills needed when writing the results, Skills are needed when writing the discussion, Skills are needed when writing the conclusions, Useful Phrases, How to ensure paper is as good as it could possibly be the first- Time Submission

Reference (s)	
1	Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2	Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3	Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4	Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011