Manufacturing Engineering

Subject Name	Code	L-T-P	Credit	Contact Hours
Semester-1				
Machining Science	ME6L301	3-1-0	4	4
Advanced Manufacturing Processes-I	ME6L302	3-1-0	4	4
DE 1		3-0-0	3	3
DE 2		3-0-0	3	3
DE 3		3-0-0	3	3
Machining Science and Surface Engineering Lab	New code	0-0-3	2	3
Advanced Manufacturing Processes Laboratory-I	ME6P351	0-0-3	2	3
Total			21	23
Semester-2				
Advanced Manufacturing Processes-II	ME6L303	3-1-0	4	4
Digital Manufacturing	ME6L320	3-1-0	4	4
DE 4	Elective	3-0-0	3	3
DE 5	Elective	3-0-0	3	3
Advanced Manufacturing Processes Laboratory-II	ME6P352	0-0-3	2	3
Manufacturing Simulation Lab	ME6P350	0-0-3	2	3
Total			18	20
Semester-3				
Thesis Part – II	ME6D002		15	
Total			15	
Semester-4				
Thesis Part – III	ME6D003		15	
Total			15	
		Total Credits:	**68**	

***The students may opt for either an open elective or an elective from another department (with the consent of the teaching faculty and the faculty advisor) against any one of the department electives.**

Syllabus

Subject Code: ME6L301	Subject Name: Machining Science	L-T-P: 3-1-0	Credit: 4
Pre-Requisite (s):			

Course objectives:

- The Primary objective of the course is to make the students capable enough to analyze the conventional machining processes using principles of plasticity and shear, taking into consideration the process parameters such as speed, feed and depth of cut, tool geometry, materials and use of coolant.
- Students will be able to analyze the mechanical and thermal aspect of conventional machining through the models based on the laws of physics.
- They will also learn about the types of tool wears and their effect on the process performance and techniques to overcome these issues.

Course content:

Geometry of cutting tools: Turning, milling and drilling in different reference systems;
Mechanism of chip formation by single point tools, drills and milling cutters; chip breakers;
Estimation of cutting force: Theoretical and experimental determination;
Oblique cutting: Direction of chip flow, Merchant's solution for oblique cutting;
Source of heat generation in machining, Measurement and modeling of cutting temperature, cutting fluids and their characteristics;
Cutting tools: Essential properties and various tool materials, Mechanisms of tool wear and failure;
Economics of machining process;
Vibration and chatter in machining and their remedy;
Surface roughness and Surface integrity, Features used to assess surface integrity;
Grinding: Mechanism of chip formation; Modelling of force and specific energy; Temperature measurement and thermal modeling; and Assessment of residual stress in machining, grinding; instruments and technique of measurement.

Recommended Books:

Metal Cutting: Theory And Practice By A Bhattacharyya, New Central Book Agency, 2010
Metal Cutting Principles By M C Saw, Oxford University Press, 2002
Machining and Machine Tools By A. B. Chattopadhyay, Wiley India, 2011
Fundamentals of Machining and Machine Tools By Boothryd and Knight, 2nd ed., Markel Dekker Inc, 1989
Fundamentals of Machining Processes: Conventional and Nonconventional By Hassan Abdel-Gawad El-Hofy, CRC Press, 2006.
Manufacturing Processes By J. P. Kaushish, PHI Learning, 2010

Manufacturing Processes 1: Cutting By Fritz Klocke, Aaron Kuchle Springer, 2011

Subject Code: ME6L302	Subject Name: Advanced Manufacturing Processes-I	L-T-P: 3-1-0	Credit: 4
Pre-Requisite(s): None			

Course objectives:

- The primary objective of this course is to make students learn about various fundamental of engineering, materials, advanced casting, welding and forming processes and their application. This will help them to build up the idea about suitability and requirement of each process for specific operations, mainly for precision manufacturing with dimensional and geometrical complexity.

- The students also learn the processing of advanced materials, alloys, MMCs as well as polymers and composites due to their increasing demand in various applications. The pre requisite of the course would be knowledge of primary manufacturing processes, casting, forming and welding.

- Students will also learn the advancements in powder metallurgy techniques and their applications, so that in future they can apply those ideas for manufacturing of components using advanced materials and MMCs, which are otherwise difficult to produce using conventional techniques.

Course content:

Fundamentals of materials: Characterization techniques, Phase transformation, Strengthening mechanisms, Diffusion in solids, Heat treatment, Corrosion in metals, Non-destructive Techniques Gating and risering, Nucleation, Grain growth, and solification, Advanced metal casting techniques.
Advanced Welding techniques: Cold metal transfer welding, Plasma arc welding; Electron Beam welding; Laser beam welding, Wire additive manufacturing etc.
Basic Processes, Advanced forming techniques, High energy rate forming, Superplastic forming; Incremental forming.
Powder metallurgy: Powdered metals and fabrication procedures, Preparation of powders, Compacting and sintering, Hot and cold pressing (HIP, CIP).
Polymers and composites processing.
Ultrasonic nano crystal surface processing, surface modification techniques.

Recommended Books:

- V. Raghavan, Materials Science and Engineering: A First Course, PHI Learning Pvt
- Metal casting: Computer Aided Design and Analysis by B. Ravi, PHI Learning Pvt. Ltd. 2010
- Advanced Welding Processes: Technologies and process control by J Norrish, Woodhead Publishing, 2006
- Advanced Methods in Material Forming by D.Banabic, Springer, 2007
- Powder Metallurgy: Science, Technology and Applications, P.C. Angelo, R. Subramanian, PHI Learning Pvt. Ltd. 2008

Subject Code: ME6PXXX	Subject Name: Machining Science and Surface Engineering Lab	L-T-P: 0-0-3	Credit: 2
Pre-Requisite(s):			

- Grinding of flank and rake surfaces of single-point cutting tool to provide suitable tool geometry.
- To study the chip-related features (Types, color, chip-compression ratio, chip serration etc.) during machining of different work materials.
- To study the effect of cutting parameters on cutting forces, temperature (using a piezo-electric dynamometer and infrared thermal camera) along with surface finish produced during machining.
- To evaluate the effect of mist cooling and flood cooling on the machinability of various alloys.
- To evaluate the cutting performance of coated tools during the machining of hard materials operation in comparison to uncoated tools.
- To evaluate the performance of surface-engineered cutting inserts during the turning operation.
- To study the effect of cutting parameters on the surface topography and work surface integrity after machining.
- Study on the measurement of the corrosion resistance of work surface after machining operation.
- Study on the performance of Hybrid machining operations (Vibration assisted and/or Laser-assisted) w.r.t. tool wear and temperatures during machining of hard materials
- To measure the vibration and energy consumption of a machine tool during the cutting operation.
- Effect of wheel speed and table feed on surface finish during grinding operation.
- Super finishing operations (Lapping/ honing/ burnishing).
- Micro feature generation for electronic application using micro-milling/micro drilling/ micro turning.
- Evaluation of Geometrical and dimensional tolerance (GD&T) of machined surface using CMM.
- NC part programming for the rotational job to be machined at the CNC lathe.
- NC part programming for the prismatic job to be machined at the CNC machining centre.

Subject Code: ME6P351	Subject Name: Advanced Manufacturing Processes Laboratory-I	L-T-P: 0-0-3	Credit: 2
Pre-Requisite(s):			

Advanced casting process: casting of a given component through Investment casting;

Advance welding techniques:

Experimental study of the effect of process parameters on the quality of weld nugget in Resistance spot welding;

Experimental study of process performance of pulsing Arc welding with variations in process parameters;

Wire additive manufacturing;

Process performance analysis of Cold metal transfer welding through experiment.

Experiment on process requirements of Plasma arc welding;

Study of power and scan speed on weld quality & HAZ in Laser beam welding;

Assessment of process performance of Friction Stir welding (FSW) ;

Assessment of residual stress during welding using X-Ray diffraction and through advanced blind hole drilling techniques;

Experimental study of Incremental forming technique;
High deformation techniques such as friction stir processing (FSP) and assessment of residual stress;

Mechanical properties of powder compacts and effect of Hot Isostatic pressing on compact quality;
Micro forming techniques, Formability analysis.

Study of Various coating techniques, effect of process parameters:
Plasma spray coating; Thermal spray coating; Low velocity oxy-fuel (LVOF) coating; High velocity oxy-fuel (HVOF) coating; Pulsed TIG cladding

Laser surface modification: effect of power and speed on depth of modification.

Subject Code: ME6L303	Subject Name: Advanced Manufacturing Processes-II	L-T-P: 3-1-0	Credit: 4
Pre-Requisite(s): None			

Course content:

Introduction - Classification and capability based on materials;
Mechanical machining – Types: Ultrasonic machining (USM), Abrasive Jet Machining (AJM), Abrasive Flow Machining (AFM), Water Jet Machining (WJM) – Principle, analysis and applications;
Electro chemical machining - Chemical material removal – Principle, analysis and applications;
Types: Electro chemical machining (ECM), Electro chemical drilling (ECD), Electro chemical honing (ECH), Shaped tube electrolytic machining - Principle, analysis and applications;
Thermo electrical machining – Types: Electrical discharge machining (EDM), Electrical discharge wire cutting (EDWC) - Principle, analysis and applications;
Electron beam machining (EBM); Plasma Arc Machining (PAM); Ion Beam Machining (IBM) - Principle, analysis and applications;
Laser beam machining (LBM) – Laser cutting, Drilling, welding, laser ablation (micro-machining), additive manufacturing etc. - Principle, analysis and applications;
Hybrid machining processes, their advantages: ECG, ECDG, Electrolytic in process dressing grinding (ELID), Laser assisted hybrid machining etc.
Advanced coating processes: Physical and chemical vapour deposition, Thermal spray techniques such as plasma spraying etc.
Mathematical models for the different processes to estimate material removal rate, part geometry etc.

Recommended Books:

Nontraditional Manufacturing Processes By Gary F. Benedict, CRC Press, 1987
Advanced Machining Processes By Prof. Vijay Kumar Jain, Allied Publisher, 2007.
Machining Science by Ghosh and Mallik
Advanced Analysis of Nontraditional Machining By Hong Hocheng, Hung-Yin Tsai, Paperback, 2012.
Nonconventional Machining BY **P. K. Mishra** Narosa Publishing House, 1997.
Advanced Machining Processes: Nontraditional and Hybrid Machining Processes By Hassan El-Hof, Mc Graw Hill, 2005.
Manufacturing Processes By J. P. Kaushish, PHI Learning, 2010.
Coating and surface treatment systems for metals: a comprehensive guide to selection, by Joseph Edwards, ASM Intl., 1997
Handbook of Thin-Film Technology, Hartmut Frey · Hamid R. Khan, Springer, 2015

Laser Material Processing By W. M. Steen and J. Mazumder, Springer, 4th Ed. 2010.

Laser Fabrication and Machining of Materials By Narendra B. Dahotre & Sandip P. Harimkar, Springer, 2008.

Laser Fundamentals By William T. Silfvast, Cambridge University Press, New Delhi, 2nd South Asian Edition, 2004.

Subject Code: ME6L320	Subject Name: Digital Manufacturing	L-T-P:3-1-0	Credit: 4
Pre-Requisite(s):			

Course objectives:

- The course objective is to make students learn about the digital description that is required for direct fabrication of products from raw materials. The pre-requisite of the course would be knowledge of a broad range of conventional manufacturing processes for making products.
- The students will learn concepts of digital design, additive and subtractive digital manufacturing and shape digitization and manufacturing in a single course for comprehensive understanding of the technology and to feel its potential in modern manufacturing practices.

Course content:

Digital design: Geometrical design of curves, Surfaces and solids, Introduction to computer aided engineering analysis and optimum design. Consideration of manufacturing and assembly aspects in design;
Shape digitization: 3D object scanning, Solid reconstruction from point cloud and tessellated data, Downstream applications;
Digital manufacturing: Subtractive manufacturing: Basic architecture, Control hardware and software details, Tooling, Sculptured surface machining;
Additive Manufacturing: Basics, Hardware details and capabilities of commercial systems, Planning of material addition, Rapid tooling solutions;

Computer-Aided Process Planning: CAPP and route sheet development, CAPP system, Computer Aided plant layout, Computer Aided Production Planning and Control, Algorithms for CAPP;

Product Database Management Systems: Types, Management Information System, Manufacturing data preparation, Shop-floor control, automatic identification systems (sensors, trackers), Product life cycle management; and

Introduction of Industry 4.0. Introduction to Smart Manufacturing.

Recommended Books:

Fundamentals of Digital Manufacturing Science, by Z. **Zhou**, S. **Xie,** D. **Chen, Springer, 2012**

Rapid Prototyping: Principles and Applications By C.K. Chua, K.F. Leong, C.S. Lim, John Wiley, 2010

Mastering CAD CAM By Ibrahim Zeid, McGraw Hill, 2005

Automation, production systems, and computer-aided manufacturing By M P Groover, Pearson, 2016

Subject Code: ME6P352	Subject Name: Advanced Manufacturing Processes Laboratory – II	L-T-P: 0-0-3	Credit: 2
Pre-Requisite(s):			

Ultrasonic machining (USM): Effect of frequency and amplitude of vibration on MRR;

Die shinking electro discharge machining (EDM): Effect of process parameters on MRR and surface roughness;

Wire electro discharge machining (WEDM): Effect of process parameters on MRR and kerf geometry;

Laser Processing of materials: effect of process parameters on output geometry/ quality, MRR etc.

- Laser cutting/ drilling
- Pre-placed laser cladding
- Laser direct deposition
- Laser welding, laser Bending

Electro chemical machining (cutting, drilling): effect of process parameters MRR and cut/ drill geometry;

Electro-forming: effect of process parameters on deposition rate and surface characteristics of the product;

Chemical Etching: effect of process parameters on etch rate;

Abrasive water jet machining: effect of process parameters on MRR;

Analysis of surface profile, measurement of surface roughness for surface generated through different non-conventional routes;

Study of circularity error during drilling using CMM/ Talyrond machine;

Study of microhardness/ nano hardness; assessment of heat affected zone in different machining process;

Design and Manufacturing of product for Rapid Prototyping

Subject Code: ME6P350	Subject Name: Manufacturing Simulation Lab	L-T-P: 0-0-3	Credit: 2
Pre-Requisite(s):			
CAD software (SolidWorks) introduction: Single object modelling, assembly of objects; Numerical simulations and modeling of different manufacturing systems and processes using commercial software, like ABAQUS, DEFORM, MATLAB, etc. viz.: Modelling of simple processes, like hardness testing, deflection of beam, etc.; Generation and distribution of stress during sheet and bulk forming processes; Modelling of machining process (turning) and chip formation; Modelling of heat transfer and temperature distribution during various thermal processes (heat treatment, thermal non-conventional machining processes); Feature extraction and tool path generation; CNC programming using software like SolidCAM, CNCSimulator Pro, etc.; Network problem and CAPP problem solutions using MATLAB etc.			