

**IIT Mandi**  
**Proposal for a New Course**

**Course Number:** ME 510

**Course Name:** Advanced Manufacturing Processes

**Credits:** 3-0-0-3

**Prerequisites:** Basic Manufacturing Processes (IC-141) and/or instructor's consent

**Intended for:** UG/MS/PhD

**Distribution:** Elective for ME

**Semester:** Odd/Even

**Preamble:** Manufacturing is a wealth-producing sector that contributes hugely to the GDP of any country. One of the widely-used definitions of advanced manufacturing involves the use of technology to improve product and/or processes with a relative technology being described as "advanced". Manufacturing covers wide areas of inputs, processes and products. It reaches out to the demands of production for thousands of different variants and types of goods. Manufacturing covers a wide variety of situations ranging from robot controlled mechanized lines of production line to simple day to day use equipment with mechanical activities. This course is intended to build up the concepts and fundamentals pertaining to advanced manufacturing processes with respect to advanced metal casting processes; advanced machining processes, advanced metal forming processes, advanced joining processes, additive manufacturing, computer aided manufacturing. The course also attempts to present a bird's eye view of the extent of alterations involved in these processes.

**Course Outline:** The course aims to provide the students understanding the fundamental concepts and techniques in advanced manufacturing processes such as material machining, casting, joining, forming and additive manufacturing.

**Course Modules:**

**Module-1: Introduction to Advanced Manufacturing Processes (4 contact hours)**

General trends in manufacturing, Introduction to advanced manufacturing, overview and need; selection of manufacturing process; fundamentals of materials and their mechanical, physical and manufacturing properties; introduction to different types of materials - metals and alloys, polymers, glass and ceramics, semiconductors, composites and nanomaterials.

**Module-2: Metal Casting and Foundry Techniques (8 contact hours)**

Physics of solidification - nucleation and grain growth; solidification of pure metals and alloys; progressive and directional solidification; rate of solidification; Chvorinov's rule; Riser and gating system design; aspiration effect; Advanced casting processes: centrifugal and continuous casting processes, squeeze casting, vacuum mould casting, evaporative pattern casting, semi-solid metal working processes, ceramic shell casting, microwave casting; Casting defects; testing, inspection and quality control; product design considerations; economics of metal casting, significance of modelling and simulation in improving cast quality and cost reduction.

**Module-3: Forming Processes****(7 contact hours)**

Metal forming fundamentals; material behaviour during metal forming; temperature during metal forming; strain rate sensitivity; yield criteria of metals; mechanics (stress strain analysis) of forming processes- rolling, forging, drawing, force analysis in deep drawing, bending extrusion etc.; punching and blanking- mode of metal deformation and failure; two-dimensional model and fracture analysis; determination of working force; details of high energy rate forming (HERF) process; electro-magnetic forming; explosive forming; electro-hydraulic forming; stretch forming; contour roll forming. Advanced plastic moulding processes – injection moulding.

**Module-4: Material Removal Processes****(8 contact hours)**

Basics of traditional machining- machining by cutting, abrasion; non-traditional machining- single action traditional machining and hybrid machining; advanced machining processes; principles, mathematical analysis, machining system, material removal process, process parameters and applications of ultrasonic machining (USM), abrasive water jet machining (AWJM), electrochemical machining (ECM), chemical milling, photo chemical milling, electro polishing, electro discharge machining (EDM), electron beam machining (EBM), and laser beam machining (LBM) processes, abrasive flow machining (AFM), bio-machining, microwave machining, plasma beam machining, ion beam machining, elastic machining, micro and nano machining.

**Module-5: Material Joining Processes****(8 contact hours)**

Classification of material joining processes, physics of welding arc, arc characteristics; arc efficiency; heat generation at cathode and anode; effect of shielding gases, isotherms of arcs, arc blow; calculation of peak temperature; width of heat affected zone (HAZ), factors affecting HAZ; residual stresses- measurement and control; shielded metal arc welding (SMAW), gas tungsten arc welding (GTAW); gas metal arc welding (GMAW), submerged arc welding (SAW), electro slag welding (ESW), electro gas welding (EGW), resistance welding (RW), cold pressure welding, ultrasonic welding (USW), electron beam welding (EBW), laser beam welding (LBW); solid state welding; microwave joining; welding of plastics.

**Module-6: Additive Manufacturing****(7 contact hours)**

Additive manufacturing processes, rapid prototyping techniques (RPT) such as liquid-based techniques- stereolithography, holographic interference solidification, beam interference solidification, solid ground curing; modelling techniques in additive manufacturing- fused deposition modelling (FDM) and shape deposition manufacturing. Selected Laser Sintering (SLS), Laminated Object Manufacturing (LOM), 3-D printing, Laser Engineered Net Shaping (LENS), accuracy in additive manufacturing processes, stair-casing and its correction, materials for additive manufacturing processes.

**Text Books:**

1. Kalpakjian, S. and Schmid, S.R., *Manufacturing Engineering and Technology*, Pearson Prentice Hall, 2008.
2. Groover, M.P., *Automation, Production Systems and Computer Integrated Manufacturing*, Prentice-Hall, 2007.

**Reference Books:**

1. Ghosh A. and Mallik A.K., *Manufacturing Science*, East-West Press Pvt. Ltd., 1985.
2. Jain V.K., *Advanced Machining Processes*, Allied Publishers, 2002.
3. Pandey P.C. and Shan H.S., *Modern Machining Processes*, McGraw Hill Publishing Company, 1980.
4. Heine and Roshenthal, *Principles of Metal Casting*, Tata McGraw-Hill Publishing Company Ltd., 1983.
5. Avitzur B., *Metal Forming Analysis*, Mc Graw Hill Publishing Company, 1980.
6. Messler R.W. Jr., *Joining of Materials and Structures*, Elsevier Butterworth-Heinemann, 1999.
7. *Welding Hand Book*, Volume 1-5, 9<sup>th</sup> edition, American Welding Society (AWS), 1999.
8. Chua, C.K. and Leong, K.F., *Rapid Prototyping: Principles and Applications in Manufacturing*, John Wiley and Sons, 2000.

#### Similarity Content Declaration with Existing Courses

S.No.	Course Code	Similarity Content	Approx. % of Content
1.	ME-635	Advanced machining and casting processes	Less than 5%
2.	ME-308	Rapid Prototyping	Less than 3%

Other Faculty interested in teaching this course: Dr. S. Powar