Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NMEC 502	Thermo-Production Processes	3	1	0	4

Course Objective

The course will enable the students to have sound theoretical and practical knowledge related to joining of materials, foundry technology and Powder Metallurgy in the manufacturing domain.

Learning Outcomes

Upon successful completion of this course, students will learn:

- Ways to make metal/alloy components through melting and pouring techniques and the associatedmanufacturing difficulties. Design of the pattern, mould and the gating system. Application 3D printing technology in making mould,core,patterns, etc.
- Fundamental requirements of the joining processes of similar, dissimilar materials; solid state and liquid state joining which includes the special welding processes.
- Additive manufacturing using the welding process for large format objects which cannot be printed with other metal printers through PBF technique.
- Ways to produce metal micro/nano powders through top down approach, characterization and applications.

Module	Topics	L+T	Learning Outcome
1	Metal Casting sand, Properties and Testing of Moulding Sand; Design of Pattern and Core, Gating System Design, Mould filling velocity and time including friction and velocity distribution in the conduit. Determination of solidification time of castings; Riser design and Placement, Casting defects. Making of mold through 3D printing: advantages and dis-advantages; present and future research direction.	8L+3T	Understanding the properties of the molding sand, design and placement of the gating system. Learning of the solidification time and fundamentals of riser design and the defects.
2	Special casting processes: investment casting, Shell casting process, pressure die casting, centrifugal casting and continuous casting etc. Application of reverse engineering and 3D printing in special casting processes.	8L+2T	Ways to overcome the limitations of sand casting process. Understanding of the special casting process and application of reverse engineering..
3	Comparison between weld joints and other joints: strength and failure criteria. Welding processes: principle and type of fusion welding processes, modes of metal transfer, heat flow characteristics, welding power supply characteristics- conventional and pulsed power sources. Concept of arc blow, forces involved during metal transfer. Input and output process parameters of welding processes, cold welding, adhesive bonding, diffusion bonding, soldering, brazing, flames, arcs, high-energy density heat sources. Weld pool solidification, mathematical modelling. Residual stresses in welded joints and their control.	8L+3T	Basics of welding processes, metal transfer, heat flow characteristics, operational parameters, Moledding aspects of welding processes.
4	Advanced welding processes: Electron Beam Welding, Laser Beam Welding, Friction Stir Welding, Explosive welding and Ultrasonic welding, Weldability tests, Defects and Inspection of welds- NDT. WAAM using TIG, MIG and other welding process considering the limitations 3D printing using powders.	10L+4T	Modern welding processes like friction stir welding, EBW, USW etc. Understanding the weldability of materials and various welding defects.

6	**Cooling and lubrication**: Heat generation and thermal damage, Analytical estimation of temperature, Various temperature measurement methods, Need for cutting fluid, Basic properties of MWF, Various delivery strategies of cutting fluid, Benefits in terms of reduced forces, temperature, surface deformation, etc. Brief introduction on sustainability regarding cutting fluids.	3L+1T	Knowledge on cutting temperature increase and potential reduction methods.
7	**Tool material and tool life**: Tool failure – catastrophic breakage, thermal dulling, and gradual wear, Different tool wear patterns, Measurement of tool wear, Tool life curve and life estimation, Effects of process parameters on tool life, Taylor's equation and modified equation. Brief account on consequence of tool wears on force, temperature, and surface subsurface quality. Tool materials and coatings with compatible work material and speed range.	4L+2T	Knowledge on cutting tool failure/wear methods, control of wear rate, tool/coating materials to enhance tool life.
8	**Machining time&Machining economics:** Actual cutting time estimation for turning, taper turning, face turning in conventional as well as CNC lathe. Cutting time estimation in drilling and different milling processes. Estimation of overall machining time per piece considering tool changing time, Optimum velocity for minimum machining time, Optimum velocity for minimum machining cost.	2L+3T	Knowledge on actual cutting time required for various machining processes and evaluation of optimum process parameters to maximize profit and productivity.
9	**Abrasive multi-grit cutting process:** Introduction, working principle, and surface quality of grinding, honing, lapping, and superfinishing process.	2L+1T	Knowledge on the working principles of secondary surface finishing methods.
10	**Smart machining factory:** Sensors for real time process monitoring through image processing and machine learning techniques. Deployment of robots to facilitate machining processes.	2L+0T	Knowledge on the digital manufacturing.
	Total	**42L+14T**	

Text books:

1. Machining and Machine Tools by A. B. Chattopadhyay,Wiley.
2. Metal Cutting: Theory and Practice by A. Bhattacharya, New Central Book Agency.

References:

1. Manufacturing Engineering and Technology by S. Kalpakjian and Schmid, Pearson Education.
2. Metal Cutting Theory and Practice by D. A. Stephenson and J. S. Agapiou, CRC Press.