WELDING PROCESSES

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PRE-REQUISITES : Graduates of Metallurgical/Mechanical/Automobile/Production Engineering

INTENDED AUDIENCE : Masters students in Metallurgical, Mechanical, Automobile and Production Engineering. Practicing welding engineers, welders, R&D personnel in academia and national laboratories, quality management personnel from welding and manufacturing industries and research scholars who are working in welding and joining.

INDUSTRIES APPLICABLE TO : Construction, Fabrication, Automobile and Power generation industries and research labs

COURSE OUTLINE :

The modern material assemblies require the combined use of alloys for a given commercial application. Welding technologies are of critical importance for the construction of virtually all components of the assemblies. This course aims to elaborate the physical principles of arc, plasma, laser, resistance spot, electron beam and solid state welding processes. This includes, physics of electric arc-plasma, engineering the arc-plasma for welding, metal transfer and mass flow in the weld pool, laser/electron beam - material interactions, pressure and force balance in keyhole mode power beam welding, fundamentals of heat generation by Joule heating and process principles and overview on types of resistance and solid state welding processes.

ABOUT INSTRUCTOR :

Prof. Murugaiyan Amirthalingam is currently working as an Assistant Professor in IIT-Madras. His research and teaching interests include welding metallurgy, welding processes development, steel product development and additive manufacturing.

COURSE PLAN :

Week 1 : Introduction to the course, learning outcomes, general survey and classification of welding processes, Conventional fusion welding processes, Principal heat sources
Week 2 : Physics of welding arc – Part IGeneral characteristics of an arc, ionisation, dissociation, arc column, anode and cathode fall zones.
Week 3 : Physics of welding arc – Part IIElectrical conductivity of the arc, heat transfer inside the arc and arc ignition.
Week 4 : Introduction to arc welding processes – Part I Principles of gas tungsten arc welding, plasma arc welding, advances in gas tungsten arc welding
Week 5 : Electrical power sources for welding - General characteristics, conventional and electronic power regulator systems - Tapped transformers, Moving-iron control, Variable inductor, Magnetic amplifier, SCR phase control, Transistor series regulator, Secondary switched transistor power supplies, Primary rectifier-inverter, hybrid designs and microprocessor controlled power sources.
Week 6 : Introduction to arc welding processes – Part II Gas metal arc, shielded metal arc, flux cored arc, submerged arc welding -consideration of shielding gases, electrode polarity, current setting, types of metal transfer, process efficiency, melting rate, spatter losses and influence of external magnetic field on arc stability and Advanced GMAW processes. Electrode coverings and their functions, types of fluxes,
Week 7 : Fundamentals of resistance welding – Part IProcess principles and overview on types of processes (spot, projection, butt, seam, and flash) Joule effect and temperature distribution.
Week 8 : Fundamentals of resistance welding – Part IIProcess application range and typical problems (welding thin to thick material, welding of coated/ painted materials, welding dissimilar materials,mass effect, shunt effect, Peltier effect, resistance brazing.
Week 9 : Introduction to power beam welding processesPlasma, laser and electron beam welding processes - principles and modes of operation, applications and advantages.
Week 10 : Principles of power beam welding processes Keyhole formation, power densities, forces acting in keyhole, pressure balance for a generalised keyhole, heat transfer in laser and electron beam welding processes.
Week 11 : Introduction to pressure welding processes - solid state bonding, friction welding, friction stir welding, ultrasonic welding, explosive welding, diffusion bonding and adhesive bonding.
Week 12 : Principles and operational considerations of pressure welding processes